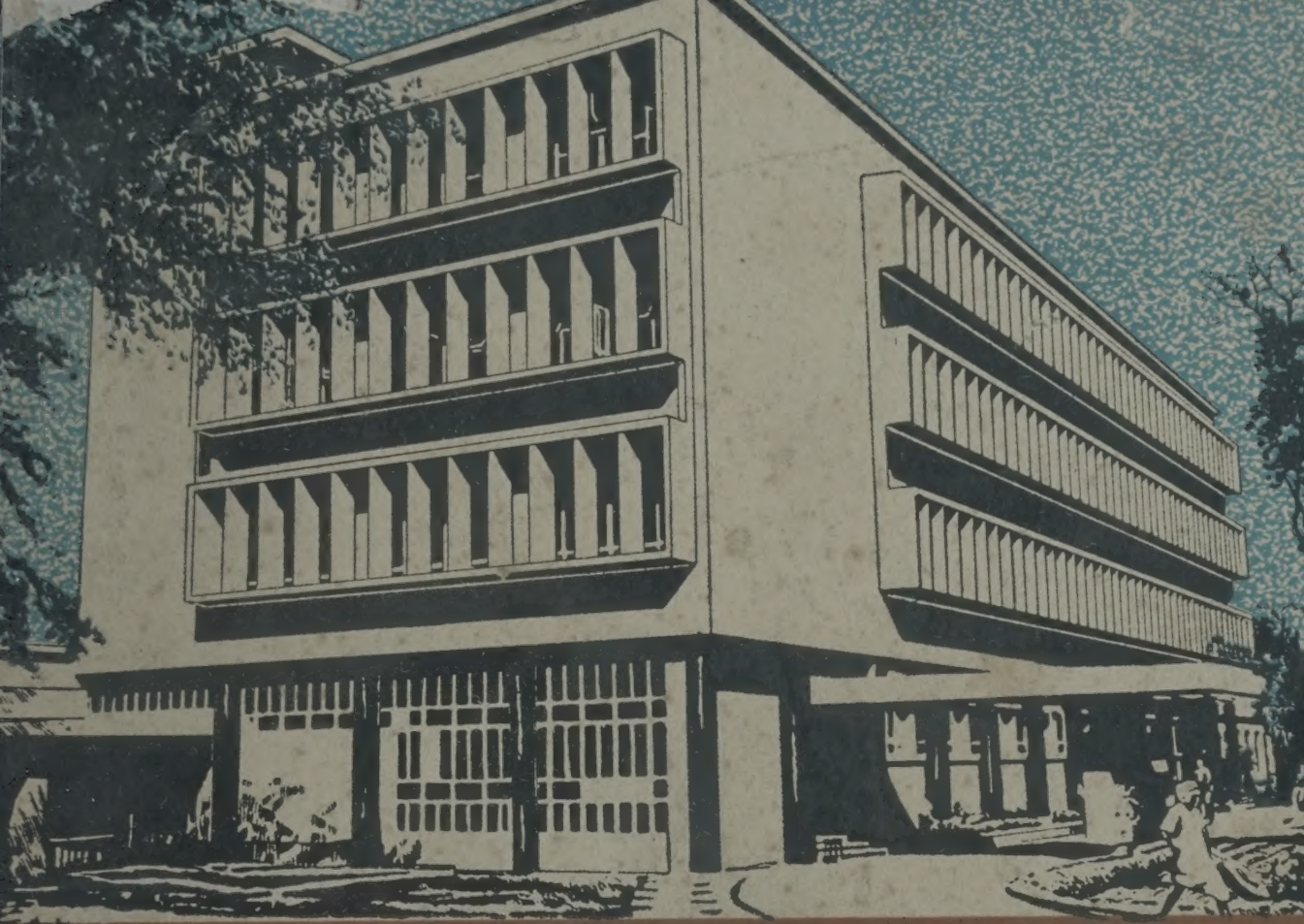


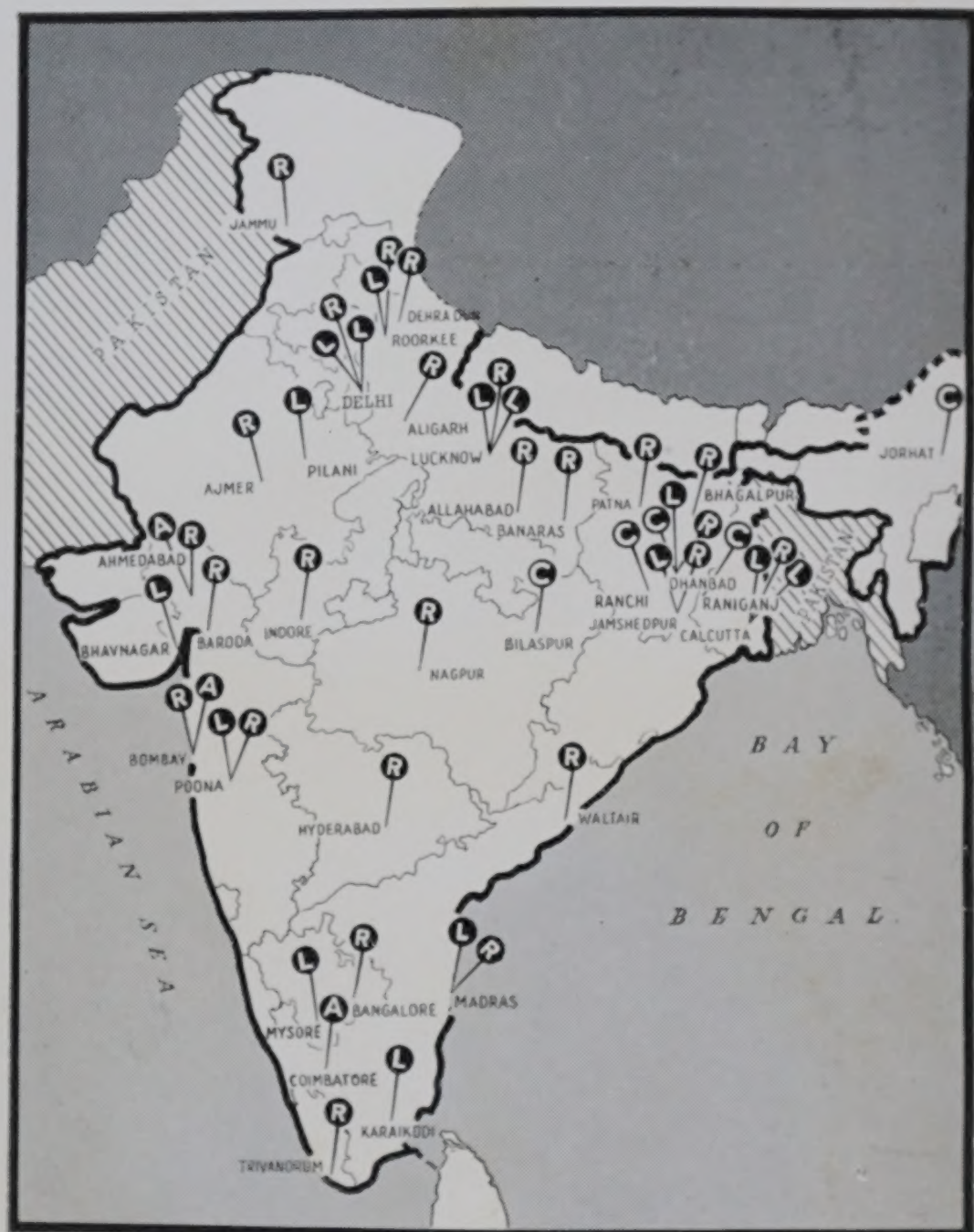


**COUNCIL OF
SCIENTIFIC & INDUSTRIAL
RESEARCH
A REVIEW**

1954

COUNCIL OF
SCIENTIFIC & INDUSTRIAL RESEARCH
INDIA

A REVIEW



DISTRIBUTION OF C.S.I.R. RESEARCH ACTIVITIES.

[A — Co-operative Research Associations. C — Coal Survey Stations.
L — National Laboratories. R — Research Schemes.]

COUNCIL OF
SCIENTIFIC & INDUSTRIAL
RESEARCH
INDIA

A REVIEW



NEW DELHI

1954

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I

INTRODUCTION

THE importance of scientific research as a vital factor in industrial advancement has been recognized in India only in recent years.

The shortcomings in India's industrial organization became apparent during World War I and the Industrial Commission (1918) reported that the position of research was quite unsatisfactory, and that in the interests of industrial development, measures should be taken to promote research. Some progress was made during the two decades between the two World Wars, but such research was for the most part uncoordinated and contacts between research centres and industries were few and inadequate. The Government of India established, in 1935, the Industrial Intelligence & Research Bureau with the object of "making a beginning and to lay the foundation on which a research organization suitable for the needs of the country could later be constructed". An Industrial Research Council, consisting of representatives of the Central, Provincial and State Governments, was set up to advise on measures for the co-ordination and development of industrial research. A research branch of the Bureau was located in the Government Test House, Alipore (Calcutta), but its activities and scope were circumscribed by its limited finances, its annual budget being Rs. 2 lakhs.

The inadequacy of the Industrial Research Bureau became manifest when World War II broke out and the scientific resources of the country had to be mobilized for the war effort. Imports of industrial materials of all kinds ceased and there was simultaneously an immense increase in the demand for them. The need for making India industrially self-sufficient and an efficient base for war supplies was urgent. The Industrial Research Bureau was kept in abeyance and, in 1940 the Government of India established the Board of Scientific & Industrial Research, for a period of two years in the first instance, "to advise Government as to the lines on which industrial research should be conducted and the channels into which it should be guided in order best to serve the object of ensuring the co-ordinated development of Indian industries, particularly of those the importance and possibilities of which have been prominently brought into the fore-front as a result of the conditions created by the war." The Board was to "utilize and co-ordinate the work of the existing organizations already employed in this field. It will survey the work that is being done by them, invite proposals from all sources, initiate discussions, and make recommendations to the Government of India who will prescribe from time to time the general lines on which industrial research should be undertaken and pursued. The Board will also report to the Government of India what specific problems should, in its opinion, be assigned for investigation to the staff directly under the Board on the one hand and to the various scientific and research institutions in the country, including university laboratories on the other."

One of India's foremost scientists with considerable experience of scientific research and its practical applications was appointed Director,

Scientific & Industrial Research and Scientific Adviser to the Government of India and was entrusted with the direction of the activities of the Board. The laboratories of the Industrial Research Bureau were placed at his disposal and expanded.

By 1941, the activities of the Board had progressed sufficiently and attention had to be directed to the commercial utilization of the results of research. An Industrial Research Utilization Committee was set up "to advise generally on the best methods of utilizing research results and the terms and conditions on which they should be released to industry".

A Central Organization

The working of the Board of Scientific & Industrial Research emphasized the need and provided the basis for a central organization to plan research on a comprehensive scale, to bring about effective co-ordination in the research activities of the country and to promote the application of research for national development. The laboratories of the Director, Scientific & Industrial Research were shifted to Delhi in 1942. The Government decided, in 1942, to create a fund, called the Industrial Research Fund, "for the purpose of fostering industrial development in the country" and the Council of Scientific & Industrial Research was constituted as an autonomous body under the provision of the *Registration of Societies Act XXI of 1860* to administer the fund. The administration of the Council was vested in a Governing Body nominated by the Government, and the Board of Scientific & Industrial Research and the Industrial Liaison Committee were made advisory bodies to the Governing Body. The functions assigned to the Council were:

1. the promotion, guidance and co-ordination of scientific and industrial research in India including the institution and the financing of specific researches;
2. the establishment or development and assistance to special institutions or departments of existing institutions for specific studies of problems affecting particular industries and trades;
3. the establishment and award of research studentships and fellowships;
4. the utilization of the results of researches conducted under the the auspices of the Council towards the development of industries in the country and the payment of a share of royalties arising out of the development of the results of researches to those who are considered as having contributed towards the pursuing of such researches;
5. the establishment, maintenance and management of laboratories, workshops, institutes and organizations to further scientific and industrial research and to utilize and exploit any discovery or invention likely to be of use to Indian industries;
6. the collection and dissemination of information in regard not only to research but also to industrial matters generally;
7. publication of scientific papers and a journal of industrial research and development; and
8. any other activities to promote generally the objects of the resolution.



C.S.I.R. SECRETARIAT
NEW DELHI

The Council's research activities in the Director's laboratories at Delhi and under the grants-in-aid scheme were continuously increasing. The Council was also offering facilities to industrial firms for conducting researches in its laboratories on the basis of agreed financial contributions.

Though occupied with the urgent problems of war importance, the Council, since its inception, directed attention to the planning of research to meet post-war needs. The various Research Committees, which had been set up to advise the Council on financing research schemes in the laboratories of universities and research institutes, were directed to initiate research activity according to a planned programme. Plans were formulated for the building up of a network of laboratories. The valuable work of the Council received the appreciation of the Government. Leaders of industry evinced keen interest in its constructive activities and gave support to them by munificent donations. The Government of India announced in 1944 a grant of Rs. 1 crore for the construction and equipment of "a chain of research institutions". Even as early as 1942, proposals for the establishment of a National Physical Laboratory and a National Chemical Laboratory had been made and accepted. Additional laboratories had been proposed and, by 1944, plans had also been prepared for the setting up of the National Metallurgical Laboratory, the Fuel Research Institute and the Central Glass & Ceramic Research Institute.

Research Planning

The Governing Body of the Council at its fifth meeting, held at Bangalore on 1 December 1943, appointed a Research Planning Committee, with Sir R. K. Shanmukham Chetty as chairman, to undertake "a comprehensive survey of the existing facilities for scientific and industrial research in India and to report on necessary measures of co-ordination, control, direction and development of such research by various agencies and also on other steps necessary for the planning of such research in post-war India". After a detailed study of the various issues referred to it, the Committee presented a comprehensive report embodying specific proposals for the development of scientific and industrial research in India on the basis of a 5-year plan. Its main recommendation was the establishment of a central research organization, to be called the National Research Council, consisting of representatives of science, industry, labour and education with the following functions:

1. to organize and maintain national laboratories;
2. to establish and maintain specialized research institutes;
3. to stimulate pure and applied research in universities by grants-in-aid and by institution of scholarships and fellowships;
4. to provide for the immediate problem of the dearth of technical and research personnel by the inauguration of scholarships available in India and abroad;
5. to co-ordinate research activities of all the existing research institutes and departments of Government and undertake the planning of research programmes on a comprehensive basis;
6. to stimulate and encourage research activities by industry;
7. to function as a National Trust for patents;
8. to set up a Board of Standards & Specifications; and

9. to function as a clearing house, encourage deserving scientific and technical societies and foster the growth of new ones on appropriate lines.

The Committee recommended that the scheme of national laboratories should be expanded to provide for the following specialized institutes: (i) Institute of Food Technology; (ii) Metallurgical Institute, (iii) Fuel Research Institute; (iv) Glass & Silicate Research Institute, (v) Oils & Paints Institute; (vi) Buildings & Roads Institute; (vii) Leather & Tanning Institute; (viii) Industrial Fermentation Institute and (ix) Electro-Chemical Institute.

The Committee further recommended that contributions from private enterprise for co-operative associations and universities for purposes of research should be treated as permissible items of expenditure in computing income tax leviable on industrial concerns.

For ensuring the continuity of the activities of the proposed National Research Council on a progressive scale, the Committee recommended the levy of a cess of one-sixteenth of one per cent on industrial production, including the gross income of railways, to defray half the expenditure of the National Research Council, the other half being met by a grant from general revenues.

Many of the functions of the National Research Council, proposed by the Chetty Committee after a comprehensive survey of the scientific needs of the country, were being carried out by the Council of Scientific & Industrial Research. There was evident need for enlarging the scale of its activities. The Council had taken the initiative in encouraging industry to form co-operative research associations and had recommended to the Government that expenditure on research and donations to research institutions by industry should be exempted from income tax, which was accepted by the Government.

The Industrial Research Utilization Committee was replaced, early in 1947, by a more compact body — the Industrial Liaison Committee — which was transferred to the Ministry of Industry & Supply (now the Ministry of Commerce & Industry) in 1948. With the setting up of the National Research Development Corporation in 1953, the Committee ceased to function and its work has been taken over by the Corporation.

First Reviewing Committee

The Governing Body of the Council of Scientific & Industrial Research at its fourteenth meeting, held on 25 August 1947, appointed a Committee, with Sir Ardeshir Dalal as Chairman, to review the work of the Council. The Committee confined its attention to the utilization aspects of the researches carried out under the Council's auspices "so as to suggest ways and means of rendering that aspect of the work of the Council of greater practical utility".

The Committee observed in its report: "Considering the short life of the Council and the difficulties with which it was confronted, especially during the war, the results achieved were very creditable. In spite of the shortage of equipment and space, and numerous other difficulties, valuable contributions had been made by the Council towards the furtherance of the war effort as well as the peace time economy of the country."

The Committee recommended that:

1. in order to make the researches of the Council of immediate practical benefit to industrialists, they should be carried out, as far as possible, to the pilot plant stage and for that purpose adequate provision for pilot plants should be made in the national laboratories and elsewhere;
2. research schemes should be clearly defined and follow a plan of development laid down by the respective Research Committees;
3. an organization on the lines of the National Development Corporation in U.K., called the National Research Development Corporation of India, should be established with similar functions, to develop new processes in the plants of State-owned and controlled industries and of such private concerns as are agreeable and, at a later stage, to develop and exploit patents and processes in pilot plants and laboratories of its own; and
4. a Board of Engineering Research should be established under the Council.

These recommendations have been put into effect since at the instance of the Council, the Government of India have established the National Research Development Corporation. A provision of rupees one crore for pilot plants in different laboratories has been made in the First Five-Year Plan.

The Board of Engineering Research, which was established in 1950, functions as an Advisory Body of the Council. The Board formulates research schemes, puts up proposals for the establishment of research institutions, and tenders advice in connection with the development of engineering research. The collaboration between scientists and engineers, which the Board seeks to foster and promote, is of great value for industrial development.

Independence & After

It was only after the attainment of independence that scientific research received the recognition and the encouragement due to it. Scientific research was announced as a portfolio under the Prime Minister in August 1947. The Department of Scientific Research was created in June 1948, and the Ministry of Natural Resources & Scientific Research was set up in January 1951. Under the stimulus of political independence and the guidance of the Prime Minister, scientific research has made phenomenal progress in India since 1947.

The pace of the establishment of the national laboratories, for which plans had been prepared and foundation-stones for some of which had been laid, was quickened after independence and new laboratories were planned and built. Concurrently with building construction, equipping of laboratories and recruitment of staff were taken on hand. Research work was started—in some cases in buildings temporarily erected and in a few cases, in neighbouring laboratories which provided the facilities—the important consideration being that work should be taken up expeditiously, without waiting for the buildings to be completed.

Research work under the Council is carried on in its own laboratories and extra-murally in universities and elsewhere under the grants-in-aid scheme. The programme of work in each laboratory is drawn up in

consultation with an advisory board consisting of outside scientific men, industrialists and representatives of interested Government departments. The National Physical Laboratory and the National Chemical Laboratory undertake pure and basic research directed to industrial needs. A certain amount of work is also undertaken for the Government and industrial interests.

The other laboratories deal with the nation's general needs in regard to food, fuel, buildings and roads. Laboratories have been set up for investigations relating to metallurgy, leather, drugs, glass, electro-chemistry, electronics and salt. The National Botanical Garden has been established for the exploration, collection, identification, and investigation on economic plants.

The Fuel Research Institute, the National Metallurgical Laboratory, and the Central Glass & Ceramic Research Institute have been participating in a comprehensive programme of mineral development formulated by the Planning Commission in the nation's First Five-Year Plan. A Technical Co-ordinating Committee has been set up by the Council to implement the programme.

All the laboratories provide facilities for team work and pilot plant investigations. Considerable attention has been given to the provision of suitable laboratories, equipment and auxiliary staff to ensure the productiveness of research scientists. Technical aid is provided to industry in the form of advice, analytical and testing work, and investigations relating to the assessment of raw materials, etc. Contacts between research workers and technical personnel from industries are encouraged through symposia, conferences and discussions. Such contacts have proved mutually beneficial and have helped to broadening the fields for research and development.

The grants-in-aid scheme of the Council has not only helped to widen the fields of research but has also proved invaluable for the training and supply of research personnel. Under this scheme the Council has made available materials and finances for the expansion of research schools in universities. The centres in which research projects of the Council are being investigated are distributed all over the country. A wide range of subjects has received attention, e.g. measurement of geological time, calendar reform, high altitude research, synthetic petrol, blending of coals and coking, and washability of Indian coals. A comprehensive survey of the nation's coal resources, raw materials for glass and ceramic industries, aromatic and drug plants, raw materials for the manufacture of dye-stuffs and several other surveys have been undertaken.

A scientific documentation centre has been set up in co-operation with the Unesco and equipped with translating, copying and other services for assisting research workers in securing scientific literature. The Council has given considerable attention to the provision of research aids, publication of results of research and dissemination of scientific information. The Council has also undertaken a survey of technical personnel and publishes a *National Register of Scientific & Technical Personnel*.

The Council collaborates in international research projects, such as investigations connected with the ionosphere and the Polar Year. The Radio Research Committee functions as the national committee in India for the International Union of Radio Sciences and the Indian National Scientific Documentation Centre represents India on the International Federation of Documentation. Problems of theoretical and applied mechanics referred to India by the International Union of

Theoretical and Applied Mechanics are referred to the Council for necessary action.

The activities of the Council of Scientific & Industrial Research have been reviewed in the chapters which follow. The Council has so far financed 328 research schemes (Appendix II). It has taken out 207 Indian patents and 21 patents have been taken out in U.S.A., U.K. and other foreign countries (Appendix III). The processes developed under the Council's auspices and transferred to the Supply Development Council, the Royal Air Force, etc., during the war, processes leased out, processes released free of cost, and the "non-technical" notes published are listed in Appendix IV. The Council has to its credit 1,282 research papers which represent a valuable contribution to the advancement of learning (Appendix V). Besides the papers, the Council has published several standard works of reference, monographs, bulletins and reports. Special mention may be made of the *Wealth of India — A Dictionary of Indian Raw Materials and Industrial Products* and the *Indian Pharmaceutical Codex*. The *Journal of Scientific & Industrial Research* issued by the Council is widely known. The Council has brought together under its boards and committees men of vision, experience and enterprise, and it has approached problems of scientific and industrial development with energy and foresight. Its efforts have leavened the progress of science as a whole, and it has shown the great possibilities of organized and well-directed scientific research for the industrial and social advancement of the nation.

II

ORGANIZATION

THE Council of Scientific & Industrial Research is an autonomous body registered under the *Registration of Societies Act XXI* of 1860. It administers the Industrial Research Fund, to which contributions are made by the Government of India from year to year. It is attached to the Ministry of Natural Resources & Scientific Research for administrative purposes.

Governing Body

The administration of the Council is vested in the Governing Body of which the Prime Minister is the President and the Minister for Natural Resources & Scientific Research the Vice-President. The Governing Body of 21 members is composed of eminent scientists, industrialists and administrators. Some of them are also members of its advisory bodies — the Board of Scientific & Industrial Research and the Board of Engineering Research; this common membership has been particularly helpful in facilitating consideration of technical matters by the Governing Body in their proper perspective. A representative of the Ministry of Finance is a nominated member of the Governing Body.

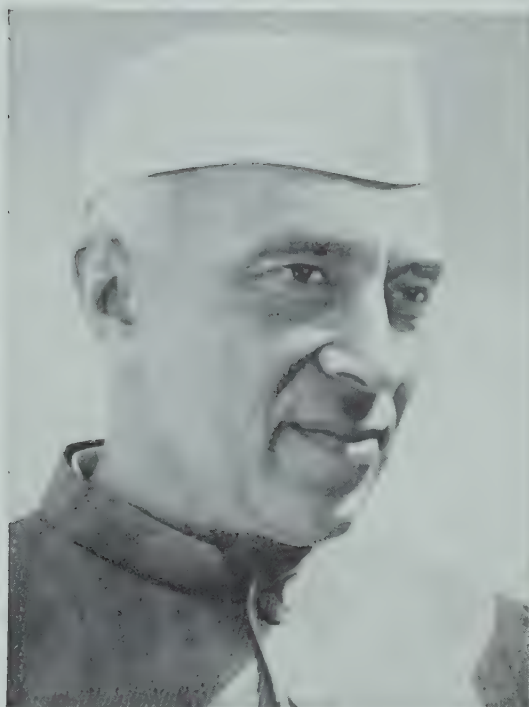
The management of the affairs and funds of the Council is vested in the Governing Body, subject to such limitations in respect of expenditure as the Central Government may from time to time impose.

All decisions on matters of policy, passing of the budget of the Council, sanctioning grants for research schemes and other matters falling within the scope of the activities of the Council are taken by the Governing Body. The budget of the Council is subject to sanction by the President of India. The President of the Council is vested with wide powers in matters of finance, within the sanctioned budget allotment, either by the constitution of the Council or by delegation by the Governing Body.

Advisory Bodies

Two standing advisory bodies — the Board of Scientific & Industrial Research and the Board of Engineering Research — advise the Governing Body on general technical matters, particularly on matters relating to grants-in-aid for investigation and research in universities and research institutions and to individuals.

The *Board of Scientific & Industrial Research* is composed of 19 members — scientists, industrialists and representatives of Government departments interested in industrial research. The Prime Minister is the President of the Board and the Minister for Natural Resources & Scientific Research the Vice-President.



SHRI JAWAHARLAL NEHRU
President
Council of Scientific & Industrial Research



MAULANA ABUL KALAM AZAD
Vice-President
Council of Scientific & Industrial Research



DR. S. S. BHATNAGAR
Principal Executive Officer and Director
Scientific & Industrial Research

The Board advises the Governing Body on proposals for (1) instituting specific researches; (2) scientific study of problems affecting particular trades and industries in scientific institutions and universities; (3) establishment of research institutes; (4) fellowships, studentships and scholarships; and (5) specific studies and surveys of indigenous resources as an essential preliminary to systematic investigation in particularly important fields of research.

The Board is assisted by a number of Research Committees. The Director of Scientific & Industrial Research is an *ex officio* member of each of these committees. All research schemes submitted to the Council for grant-in-aid are referred to the appropriate Research Committee for scrutiny and recommendation. The Research Committees keep watch on the progress of research schemes falling within their scope and also formulate long-range research projects on specific subjects. There are at present 25 Research Committees as follows: (1) Chemical Research Committee; (2) Pharmaceuticals and Drugs Research Committee; (3) Malaria Chemotherapy Research Committee; (4) Physical Research Committee; (5) Glass and Refractories Research Committee; (6) Biochemical Research Committee; (7) Plastics Research Committee; (8) Vegetable Oils Research Committee; (9) Metals Research Committee; (10) Radio Research Committee; (11) Internal Combustion Engines Research Committee; (12) Fuel Research Committee; (13) Essential Oils Research Committee; (14) Cellulose Research Committee; (15) Statistics, Standards and Quality Control Research Committee; (16) Atmospheric Research Committee; (17) Building Research Committee; (18) Leather Research Committee; (19) Research Committee on Measurement of Geological Time in India; (20) Vanaspati Research Advisory Committee; (21) High Altitude Research Committee; (22) Road Research Committee; (23) Salt Research Committee; (24) Mining Research Committee; and (25) Coal Blending and Coking Research Subcommittee.

The *Board of Engineering Research* is constituted of 19 members with an eminent engineer as chairman. It includes nominees of the Institute of Engineers (India), Indian Roads Congress, Railway Board, Ministry of Defence and Ministry of Works, Housing & Supply, the Director, Scientific & Industrial Research, scientists, industrialists and engineers.

The Board is responsible for initiating and fostering research in various branches of engineering in educational institutions, engineering laboratories and research organizations. The Board is assisted in its work by the following 5 committees: (1) Hydraulic Engineering Committee; (2) Electric and Power Engineering Committee; (3) Mechanical Engineering Committee; (4) Aeronautical Engineering Committee; and (5) Civil Engineering Committee.

Administration

The Director of Scientific & Industrial Research is the principal executive officer of the Council. He is responsible for the day-to-day administration of the Council and exercises supervisory control over its technical and research activities, including the work of the national laboratories and research under the grants-in-aid scheme. He is a member of the Governing Body and its advisory bodies. He is also the chairman of some of the Research Committees and an *ex officio* member of others. He is the Chairman of the Advisory Committee for Insdoc.

of the Editorial Committee of the *Dictionary of Indian Raw Materials & Industrial Products* and of the Editorial Board of the *Journal of Scientific & Industrial Research*.

On the administrative side, the Director is assisted by two Deputy Directors — *ex officio* Deputy Director (Administration) and Deputy Director (Technical). The *ex officio* Deputy Director (Administration) is the Secretary of the Council. The Council Secretariat staff includes, in addition to the Secretary, a Joint Secretary, a Deputy Secretary and six Assistant Secretaries. The secretariat is concerned mainly with finance, work connected with the Board of Scientific & Industrial Research and the Board of Engineering Research, general matters connected with the national laboratories, and award of fellowships and scholarships. The work connected with finance includes the preparation of the budget of the Council and of the national laboratories, disbursements on establishment, examination of the financial implications of proposals from national laboratories and maintenance of accounts of expenditure on sponsored research.

On the technical side, the Director's responsibilities include the supervision and co-ordination of the work of the national laboratories and of Research and Expert Committees, advising Government departments and Ministries on scientific matters, planning of new research laboratories and research projects, research utilization, publications and dissemination of scientific information. The Director is assisted in this work by the Deputy Director (Technical) and the staff consists of an industrial economist, a chief editor, assistant editors, publicity and information officers, junior technical officers and technical assistants.

National Laboratories

The direction of scientific research and the day-to-day administration of the national laboratories is vested in the directors of the respective laboratories. The scientific work of the laboratories is carried out in the various divisions and sections headed by assistant directors or senior scientific officers. The administrative officers look after routine administrative and financial matters. Deputy directors have been appointed in the larger laboratories to assist directors in routine administration and technical duties.

Advisory boards have been constituted for each of the national laboratories. They advise the director in framing the budgets of the laboratories for submission to the Council, scrutinizing the programmes of work, reviewing progress and recommending to the Council proposals for development. The boards are also required to discharge any other function which may be assigned to them by the Council from time to time.

Local planning committees have been formed for laboratories which are still in the planning stage. The committees determine the financial requirements of the laboratories, frame budgets and plan programmes of research. They also examine and approve the requirements of the laboratories regarding furniture, building work, etc. Planning officers are required to seek the advice of the committees in various matters relating to the construction and equipment of the laboratories. Two architects with specialized training in the planning and construction of scientific laboratories have been appointed to advise the Council in the planning of new laboratories.

RESEARCH

DIRECTOR,
RESEARCH

SECRETARY &
Ex officio D.D.S.I.R. (ADM.)

D.D.S.I.R.
(TECHNICAL)

Publications

Engineering

Planning

Liaison with
Industry

Board

The technical work of the national laboratories is co-ordinated by the Co-ordinating Committee of Directors. The Committee examines the programme of work of each laboratory with a view to co-ordinating the same with the programmes of other laboratories and with research schemes sponsored by the Council, so that duplication and overlapping may be avoided. The Committee also reviews the progress of work of the national laboratories and co-ordinates proposals for development. The Committee considers the budgets of different laboratories as framed by Local Advisory Boards. It also considers administrative matters of common interest to the laboratories.



III

RESEARCH WORK CARRIED OUT IN D.S.I.R.'S LABORATORIES

WITH the creation of the Board of Scientific & Industrial Research (1940), the laboratories and the staff of the former Industrial Research Bureau at the Government Test House, Alipore, Calcutta, came under the charge of the Director, Scientific & Industrial Research. In 1942, when the city of Calcutta was exposed to the danger of aerial bombardment by Japan, the laboratories of the Director, Scientific & Industrial Research, were transferred to Delhi and housed in the buildings of the Delhi University. The laboratories and the personnel were transferred to the Council of Scientific & Industrial Research when this body was created in March 1942.

The work of the laboratory was organized in 1944 under two sections — Physical and Chemical — each section being placed under the charge of an Acting Director. A planned programme of research was drawn up and several problems, directly related to the war effort, were investigated in collaboration with the Department of Supply, the Royal Air Force, the American Air Forces, the War Department and other defence organizations of the Government. After the cessation of the war, the work of the Council was directed to problems of a more enduring nature — fundamental and applied.

The war-time investigations were of great value in revealing the industrial potential of the country and the possibilities of utilizing the natural resources for industrial development. A brief account of the work carried out in the D.S.I.R.'s laboratories during the period 1940-49 is given below.

Physics Section

PRODUCER GAS TEST PLANT — ALTERNATIVE FUELS FOR INTERNAL COMBUSTION ENGINES

The acute shortage of petrol during the war for civilian consumption necessitated the running of motor vehicles on producer gas. A Master Testing Station was installed in the Physical Laboratories of the Council to guide and advise the routine testing of producer gas plants, which had been undertaken on different testing stations in the country. Besides, routine testing of plants manufactured in the Punjab, U P., Bihar and Rajasthan was undertaken and in collaboration with the War Transport Department of India a number of road tests were also carried out.

(a) *Standardization of Filter Papers for Gas Purity Tests* — For ensuring uniformity of procedure in bench tests at different testing stations in India, methods of standardizing filter papers used for gas purity were investigated and a standard filter paper was evolved for use in all

testing stations. Extensive tests on the flow of gases through filter papers were carried out for correlating the physical characteristics of filter paper with gas flow.

(b) *Cleaning of Producer Gas* — Investigations on the suitability of different woven fabrics and felts for use in producer gas filters were completed. On the basis of the results obtained certain varieties of drill and satin drill cloth were recommended for use. The effect of varying the packing density for cotton waste, coir, jute and other fibrous materials was also investigated to find out the optimum packing conditions for coarse filter media. To provide for wet scrubbing, which helps to eliminate corrosive impurities such as ammonia and sulphur dioxide, an improvised type of cyclone filter was developed and patented. Dry cyclone filters were also experimented upon.

(c) *Gas Purity & Power Tests* — As a result of gas purity tests on different makes of producer gas plants manufactured in the country, suggestions for improvements were made to manufacturers. The adoption of the suggestions led to the production of six types of plants conforming to the standards prescribed. A dynamometer was constructed for carrying out power tests and put into operation. Routine power output tests were included in the regular schedule of tests for gas plants.

(d) *Experiments on Gas Plants* — A producer gas plant of the British Emergency type, received from the Government Central Workshops, Kanpur, was tested with various filtering materials, with and without wetting agents and suitable modifications were introduced.

(e) *Producer Gas Fuels* — Laboratory bench tests were undertaken to test the suitability of different varieties of Indian charcoals. Tests were carried out on the use of rectified spirits and on mixtures of producer gas and rectified spirits as fuel. Road tests were also made to study the operating conditions and the possibility of using these fuels with minimum alterations in the petrol-operated engine was established.

(f) *Fuel Economy in Portable Producer Gas Plants* — Various methods, such as gas-air-heat exchanger, exhaust gas injection and steam injection, for improving the fuel economy in portable producer gas plants, were tried on the experimental truck. Of these the gas-air-heat exchanger was found to be effective and its adoption was recommended for general use.

(g) *Clinker Formation in Gas Plants* — Investigations were undertaken on the cause of white clinker formation, reported in various types of portable producer gas plants all over India. Its origin was traced to the barks of woods used in the preparation of charcoal.

(h) *Engine Lubrication & Corrosion* — Corrosion due to water-in-oil emulsions formed as a result of the presence of moisture in producer gas and its mixture with lubricating oil was studied. It was found that the addition of certain protective agents to oil, in small quantities, prevented the corrosive action of water, which gets emulsified with the oil. Demonstration trials with Nigo's oil cleaner showed that used lubricating oils can be readily reconditioned.

(i) *Air Cleaner & Ventilation in Engines* — An improved type of air-cleaning and crank-case ventilating system was developed and patented.

VEGETABLE OILS AS FUELS & LUBRICANTS

(a) The possibility of using vegetable oils as diesel engine fuels was investigated in detail. The results indicated that oils such as groundnut

oil and cottonseed oil, could be successfully employed for this purpose, with only minor adjustments in the engine. For using polong oil, certain engine parts will have to be built of corrosion-resistant alloys. Vegetable oils gave, in general, approximately the same power output, a slightly higher fuel consumption, better brake thermal efficiency and slightly more but not excessive carbon deposits, when compared with mineral oils. The results were published in a bulletin (Industrial Research Bureau, Bulletin No. 19).

Extensive work was carried out on vegetable oils as lubricants. A series of Air Ministry Oxidation tests were undertaken on various oils—castor, groundnut, cottonseed and rapeseed oils—with and without stabilizers. A number of effective stabilizers were discovered for the oils and a few blends of oils were developed and tested as lubricants for internal combustion engines. Satisfactory vegetable oil blends which compared favourably with mineral oil lubricants in almost all respects were prepared. The results of the investigation were published in the form of bulletins (Industrial Research Bureau, Bulletin Nos. 18 and 20) and are known to have been utilized by the oil companies.

(b) *Colloidal Fuels*—Preliminary experiments using vegetable oils with 35 per cent charcoal were successful but it was found necessary to develop production of fine grade charcoal to reduce wear of engine parts.

IGNITION LAG IN THE USE OF VEGETABLE OILS AS DIESEL FUELS

The work on the utilization of Indian vegetable oils as fuels for diesel engines indicated that certain vegetable oils gave a better thermal efficiency than mineral diesel oil and almost all vegetable oils gave thermal efficiencies higher than those predicted from a knowledge of their calorific values. A detailed study of the mechanism of combustion of vegetable oils, with particular reference to the determination of ignition lags was undertaken. In the absence of standard equipment, ignition lag was measured by recording the time between injection and ignition.

It was observed that the electrical conductivity of the soot film, formed on the plug inserted in the combustion chamber, was sensitive to pressure. This phenomenon was investigated in detail and the results were published.

VEGETABLE OILS AS ILLUMINANTS

Blends of vegetable oils with fusel oil were evolved as substitute illuminants for kerosene which was in short supply during the war. The results were published for general information.

STORAGE BATTERIES

Comparative performance and life tests were carried out on foreign and Indian batteries. The findings were communicated to various firms. Work was also carried out on aeroplane batteries for the R.A.F.

DRY CELL MANUFACTURE

A systematic study of indigenous manganese ores was undertaken and a technique for the manufacture of dry cells was worked out. The results were published in the form of a bulletin.

In commercial practice, manganese ores are generally mixed, to the extent of about 10 per cent, with precipitated manganese dioxide in order to increase the output of dry cells. Precipitated manganese dioxide was not available in India during the war. A method for activating ores to increase the output of cells was worked out.

CARBON PRODUCTS

1. *Electrodes for Dry Cells* — Experiments to determine extrusion characteristics of mixes containing different proportions of body and binding materials, under varying conditions of pressures and temperatures, were carried out. The effect of varying the shape of nozzles was also studied. Optimum conditions for baking extruded rods were studied and suitable furnaces designed and fabricated. A cyclone separator was designed for controlling particle size distribution of the body materials and hydraulic presses required for the production of rods, were also designed. The process was revealed to *Messrs Estrella Batteries Ltd.* for commercial development. Patents were taken out for the cyclone separator and the magnetic separator.

2. *Arc Carbons* — A machine for filling the cores of cored rods with chemicals was designed and fabricated. Conditions governing the copper plating of carbon rods were studied and suitable compositions of electrolytic bath evolved. Improved methods were developed for calcining petroleum coke. A projector was fitted up for testing the characteristics of arc carbons.

3. *Carbon Brushes* — Compositions for the production of carbon brushes of suitable hardness, current carrying capacity, etc., using coke, graphite and copper powder were evolved. Apparatus were designed and assembled for determining electrical resistance and scleroscopic hardness of brushes. Methods for connecting copper leads to brushes were studied and filling compounds were analysed. Tests were carried out on motor generators fitted with brushes made in the laboratory. Suitable equipment was designed for testing voltage drop, wear and friction of brushes under controlled conditions.

4. *Carbon Granules for Microphones* — The suitability of Indian coals for the manufacture of microphone granules was tested. While many of them were found to possess the characteristics required in varying degrees, none gave satisfactory performance in the microphone. Jangli Gali coal from Jammu State gave the best performance.

5. *Microphone Diaphragms* — Carbon discs for use as diaphragms in microphones were prepared and experimental microphones using the diaphragms were made in the laboratory workshop.

6. *Welding Rods* — Welding rods prepared from petroleum coke were tried in an automatic welding machine and showed nearly the same speed of welding when using 300 amp. current as the imported rods.

FUEL PUMP DIAPHRAGMS

Fuel pump diaphragms used in motor cars were in short supply during the war. A substitute product, which was superior to the imported product in performance, was developed, and it was found to be equally satisfactory for petrol and alcohol-petrol blends. Large-scale production was entrusted to *Messrs United Trading Co., Delhi.*

PETROL-PROOF RUBBERLESS HOSE PIPES & TUBES

A composition for the production of petrol-proof, rubberless hose pipes and tubes, with satisfactory flexibility and other characteristics, was developed during the war. The hose was certified to be satisfactory by the Burmah-Shell Oil Company and the R.A.F. Specifications for the pipe were drawn up by the Ordnance Laboratories, Kanpur. The composition of the pipe was released to the R.A.F.

PETROL, WATER & OIL-PROOF COATINGS

Petrol-proof, water-proof and oil-proof compositions suitable for coating cardboard containers were developed by processing shellac. They were supplied in quantity to the American Air Force. The composition was used as a protective coating to aircraft petrol tanks made of synthetic rubber. The coated tanks were suitable for use with Indian petrol which is rich in aromatics. The same composition was also used for plywood containers to render them petrol-proof.

LAMINATED CONTAINERS

Laminated containers were made from woven fabrics, paper, etc., and resins of various types. Petrol containers of 2 gal. capacity and jettison tanks (75 gal. capacity) for carrying petrol in aircraft were produced.

DROPABLE CANVAS-PLASTIC PETROL TANKS

A water-soluble plastic powder composition was developed from indigenous raw materials for use, under field conditions, for impregnating, stiffening and petrol-proofing dropable canvas tanks. The investigation was undertaken at the instance of the American Air Force authorities to whom the details were revealed.

UTILIZATION OF WOOD WASTE

Saw dust, wood shavings, and other forms of wood waste were treated chemically, mixed with indigenous resins and plasticizers, and pressed into sheet boards of the Masonite type.

IMPREGNATED WOOD PRODUCTS

(a) *Jute Mill Bobbins* — Investigations on the treatment of jute mill bobbins were undertaken to improve their resistance to breakage under service conditions. A composition was developed and bobbins impregnated with the composition were tested in jute mills. Details relating to the composition and the process of treatment were made available to interested firms, and representatives of some firms were trained in the technique of treatment.

(b) *Bamboo Strips for Weaving Combs* — The object of the investigation was to reduce the flexibility of bamboo strips employed in the production of weaving combs. Bamboo strips as well as finished combs were treated and tried at the Government Textile Institute, Madras, with satisfactory results. The process was released to the Principal, Government Textile Institute, Madras, free of charge for utilization by the handloom industry and for arranging demonstration to weavers in various centres.

(c) *Bamboo Gramophone Needles* — A process for hardening bamboo needles was worked out and the treated needles were used as substitutes to steel needles with satisfactory results. Treated needles could be used for playing 3 sides of 10-inch records and they could be used again after sharpening the point with a special cutter.

LAMINATED BOARDS

Laminated products have been in use for many years past and their importance and range of utility have increased with the growth of the plastics industry. Supplies of laminated products, particularly laminated boards, were scarce during the war period. A variety of products was developed by the use of indigenous materials. Patents were taken out to cover improvements in the process of manufacture and for the process of manufacturing corrugated laminated board. Physico-chemical tests were developed for testing the tensile strength, shear strength, transverse beam strength, water absorption, oil absorption, etc. Special products were developed for specific fields of application.

DRAWN LAMINATED MOULDINGS

Laminated sheets and boards possess high toughness due to the co-ordinated reinforcement of fabrics. The use of laminated boards was extended for moulding a variety of articles such as ash trays, cigarette cases, ceiling roses, switches, etc. Patents for the process were taken out in India and U.K.

HORN WASTE PLASTICS

The object of this investigation was to find alternative uses for horn wastes which are available in plenty in the country. A moulding powder was prepared by dry mixing horn waste with suitable ingredients on hot rolls or by wet mixing in an aqueous medium. By the degradation of the proteinous and resinous constituents of horn waste and chemical treatment of the resulting mass, a moulding composition similar to casein plastics was obtained. The results were patented and leased out to a firm in Coimbatore for exploitation.

COFFEE BEAN PLASTICS

At the instance of the Coffee Planters Association of India, investigations into the possibilities of utilizing raw coffee beans for the preparation of moulding powders were undertaken, and suitable compositions were

formulated. A process for the utilization of cherry coffee husk, a waste from coffee beans, to obtain moulding compositions was also developed. The composition was suitable for moulding flat sheets and shallow articles. The moulded products were tough, strong and resistant to water, they could be machined and polished to a high finish.

ARTIFICIAL WOOL FROM GROUNDNUT CAKE

A systematic investigation into the separation of proteins from groundnut cake was undertaken and a standard procedure for separating them was worked out. Compositions for spinning solutions were formulated and the tensile strength of fibres spun out from them was determined, after giving them the usual hardening treatment. An apparatus for tensile strength determination was designed and built in the laboratory.

ANTI-GAS FABRICS

For meeting the urgent demand of anti-gas cloth a formula for an anti-gas varnish, using indigenous materials, was developed and pilot plant trials were carried out. According to the specifications, anti-gas cloth should be not only impervious to toxic gases, but should also be water-proof to the extent of standing boiling water without deterioration in any of its properties. It should, in addition, be highly flexible and soft to touch and yet sufficiently hard so that the impregnating material is not scratched away mechanically. The product was also required to conform to specifications regarding tensile strength and tackiness. The process developed in the laboratory gave a product which satisfied all the requirements. The formula was made available to a large number of firms. Technical assistance was also given for ensuring large-scale production. Anti-gas cloth, worth more than one crore of rupees, was produced during the war.

To prevent leakage of gases through seam holes, a special seaming varnish was developed and thousands of gallons of this varnish were used to cover up sewing machine holes.

CROWN CORK CEMENT

An adhesive for cementing cork sheet pieces to metal blank lacquered crown caps was developed and released as technical advice to a firm in Delhi.

CASEIN GLUES

Investigations on the preparation of casein glues for plywood were carried out at the instance of casein producers, and a satisfactory composition was evolved. Plywood boards made from this glue by hot and cold pressing processes were found to possess excellent water resistant qualities.

CAPPING CEMENT

Capping cement for electric bulbs was developed from indigenous raw materials and technical details were released to Indian lamp manufacturers.

ULTRASONICS

The following problems were investigated:

1. Modes of oscillation of quartz to determine (i) the frequencies at which a quartz plate can oscillate; (ii) oscillations along different axes; (iii) effect of damping by superincumbent liquid columns; (iv) oscillations produced by exciting the quartz crystal by a complex carrier wave; and (v) simultaneous oscillations at more than one frequency.

A piezo-electric quartz plate can oscillate at its fundamental resonant frequency as determined by its thickness, and also at a number of its odd multiples. It was found that a quartz plate can oscillate not only at its odd harmonics, but also at half odds such as $\frac{3}{2}$, $\frac{5}{2}$, $\frac{7}{2}$ and even multiples of its fundamental frequency. These observations were subsequently confirmed by the Chinese workers, Tsien and Chu, working independently in the National Academy of Peiping.

A study of oscillations along different axes of a quartz plate showed that when an X-cut crystal having its facets electroplated with silver and copper is excited into thickness-wise vibrations at its fundamental frequency, feeble oscillations are also present along the Y and Z axes.

It has been established that a piezo-electric quartz plate can be made to oscillate simultaneously at more than one frequency. It has been also established that the complex diffraction pattern obtained in such a case is analogous to the use of two or more superimposed transmission gratings in optics. Another case of simultaneous oscillations was observed to occur in the case of "zeichen" or pulling up of the vibration frequencies of the crystal. In this case, the diffraction spectra of the two frequencies are present independently. The effect can also be produced by exciting the quartz crystal by two alternately pulsating carrier frequencies.

Diffraction spectra were produced by ultrasonic waves generated by a quartz plate fed with an amplitude-modulated carrier wave. It was observed that the high frequency lines were bracketed by secondary low frequency lines, as in the case of superposition of two gratings; but unlike the latter, the zero line did not show any low frequency lines enclosing it.

The phenomenon of simultaneous oscillation of quartz at several frequencies has been utilized for developing a new method for the study of dispersion of sound velocity in liquids. The method evolved eliminates most of the errors accompanying other methods.

2. Velocity and adiabatic compressibility have also been determined in a number of liquids with a view to finding out the possibility of a correlation between sound velocity and chemical constitution. The liquids studied include vegetable, essential and mineral oils. The method has been applied to the determination of mineral oil content in paraffin wax-oil mixtures containing a small percentage of oil.

3. A new method was devised for the study of absorption of ultrasonic waves in liquids and its variation with temperature and frequency.

MICA

Dielectric constant and power factor of representative samples of mica from various parts of the country have been determined.

BUILDING MATERIALS

Samples of sandstone received from the Central P.W.D. were examined to determine the causes of severe weathering in certain cases. The fault was located to an excess of lime in the stones and suggested a faulty association of materials and transfer of lime from some lime-rich source to the sandstone by percolation, etc. Studies on burnt clay or *surkhi* and puzzolana and cement-*surkhi* mortars and substitutes for Leighton Buzzard standard sand were also conducted.

PARTICLE SIZE STUDIES

A detailed study of particle size distribution was undertaken with particular reference to (i) red lead pigments for paints and (ii) clays for manufacture of pencils and rubber goods. Some theoretical work on the effect of container walls on the packing density of particles was also carried out.

METALLIC VACUUM CONTAINERS

1. At the instance of the Supply Development Committee, investigations were undertaken on the development of double-walled metallic vacuum containers, similar to glass thermos flasks. Several technical details, such as heat conduction through container lid, technique of sealing off, degassing of metal sheet, strength of walls, maintenance of vacuum type of construction, use of getters, etc., had to be investigated. A copper-to-pyrex glass seal was prepared and the copper tube brazed with the outlet steel tube so that the sealing off may be effected at the glass. An ultimate vacuum of 10^{-3} mm. of mercury was secured.

2. *Hot Food Containers* — Improvements in hot food containers were indicated. The top lid was replaced by a plywood lid coated with birlawar enamel. The introduction of a double chamber, the outer chamber being filled with hot water, increased the utility of the vessel. The results were placed at the disposal of the Supply Development Committee.

STERILIZING FILTER PADS

Filter pads required for obtaining bacteria-free filtrates in bacteriological as well as pharmaceutical preparations were prepared from indigenous materials. The pads were tested in different laboratories and proved to be satisfactory.

SOLID METAL POLISH

A composition containing white earth, binding agents and certain chemicals was formulated to give a metal polish which was comparable

to the imported products. The formula was leased out for commercial development.

Chemistry Section

PLANT ALKALOIDS

1. *Kurchi Alkaloids* — Kurchi bark is a highly valued drug in indigenous medicine for the treatment of dysentery and tuberculosis. Seven new alkaloids from the bark and the seeds of the plant were isolated and their relationship with the main alkaloid, conessine, was established. A number of derivatives were prepared and their therapeutic action investigated.

2. *Cassia Alkaloids* — The constitution of active bases of *chaksu* seeds was studied and a number of derivatives were prepared.

3. *Alkaloids of Stephania glabra* — In view of the reputed value of some *Stephania* drugs in the treatment of tuberculosis and asthma, an investigation into the constituents of *Stephania glabra* (Gindaru) was undertaken; three alkaloids, gindarine, gindarineine and gindarimine, were separated and a number of derivatives were prepared.

4. *Alkaloids of Rauwolfia serpentina* — The isolation of five physiologically active bases was reported. The alkaloids isolated from the drug collected in the Dun Valley are allied to, but not identical with, those obtained from Bihar. The drug was recommended for inclusion in the *Indian Pharmacopoeia*.

5. *Holarrhena febrifuga Bases* — This African drug, reputed to be a febrifuge, is used as a substitute for quinine. Samples from different parts of Africa were obtained and active bases from them were separated for the study of their physiological activity.

ESSENTIAL OILS

1. *Chemical Investigations on Kakra-singi* — The constituents of this drug (*Pistacia integerrima*) valued in the treatment of coughs, asthma, etc., were studied. Two crystalline compounds and an essential oil, whose composition was determined, were isolated.

2. *Allium sativum* — A systematic re-investigation of garlic was undertaken and the active principles were separated by fractionation and partitioning. Two distinct active substances, one equally active against both *Staphylococcus aureus* and *B. coli* and the other more active against *Staphylococcus aureus*, were isolated.

3. *Nim Seeds, Blossoms, Root, Bark & Leaves* — A series of bitter constituents were isolated from the oil and a process for the large-scale production of nimbidin, nimbin (crystalline), and nimbidol was evolved. A number of pharmaceutical preparations of nimbidin were standardized. Pharmacological tests and clinical trials on some of the derivatives at the King George Medical College and Hospital, Lucknow, showed that some of the compounds were non-toxic and were useful as uterine contractive stimulants; others were reported to be efficacious for skin diseases and useful as throat gargles. No bitter principle could be isolated from *nim* blossoms. Nimbin occurred as such in the root bark of the *nim* plant along with nimbidin and other water-soluble bitter constituents. The absence

of nimbin in certain collections of seeds was ascribed to variations in the maturity of seeds at the time of collection. Two acidic bitter constituents (one of them water soluble) were isolated from the leaves.

4. *Bakayan* — An investigation into the active chemical constituents of this plant, *Melia azadirachta*, which belongs to the same botanical order as *nim*, revealed that in contrast to the *nim* seed, bitter constituents are not present in the kernel but occur exclusively in the pericarp.

5. *Examination of Some Odoriferous Plants* — The odoriferous principles of the following plants were isolated and the possibilities of their use as insecticides and insect repellants were explored: (i) *Pavonia odorata* (Sugandhbala) a viscous dark brown oil, with a musk-like odour, was separated from the roots of Sugandhbala by extraction with ether and petroleum ether; (ii) *Cyperus scariosus* (Nagarmotha) — A thick viscous, light brown oil, with camphor-like odour was obtained from Nagarmotha; (iii) *Nardostachys jatamansi* (Jatamansi) — A clear brown oil with a pyridine-like odour was obtained.

PLANT COLOURING MATTERS

1. *Didymocarpus pedicellata* — Studies in pedicinin, a colouring matter derived from this plant, have shown that it exists in two physically different modifications.

2. *Chemical Examination of Vitex peduncularis* — The chemical constituents of the drug, reputed to be effective in the treatment of black water fever, were investigated. Vitexin and a crystalline neutral fraction were isolated.

3. *Chemical Examination of Sonneratia acida* — Two crystalline colouring matters and a colourless water-soluble constituent were isolated. The orange red colouring matter (m.p. 245°C.) and the lemon yellow colouring matter (m.p. 195°C.) provisionally named "Archin" and "Archinin", were found identical with emodin and chrysophanic acid. The economic possibilities of utilizing the material for the production of emodin and chrysophanic acid have been explored.

INSECTICIDES, PYRETHRUM CONSTITUENTS & PREPARATIONS

1. *Concentrated Extracts of Pyrethrum* — A process for the manufacture of biologically stable concentrates of pyrethrum, using solvents available in India, was evolved. The effectiveness of the preparations were proved by biological assays carried out at the Malaria Institute of India and the Biochemical Standardization Laboratory, Calcutta. The process was patented.

2. *Antioxidants for the Stabilization of Pyrethrins* — Derivatives of *butylated hydroxytoluene* were found to be effective for stabilizing concentrated pyrethrum extracts.

3. *Emulsifier for Pyrethrum Extracts* — An emulsifying composition, which is miscible with pyrethrum extract possessing activating and stabilizing properties, was prepared. The formula, which is covered by a patent, was revealed to the D.G.I.M.S. to meet urgent defence requirements. Its manufacture was initiated in the Medical Stores Depot, Madras.

4. *Pyrethrum Creams* — A semi-vanishing mosquito-repellent cream containing kerosene extract of pyrethrum was evolved at the instance

of the Malaria Institute of India, and manufactured by the D.G.I.M.S. during the war for use of the army. The process was patented and the details were published for the information of those interested in its commercial exploitation.

5. *Subsidiary Constituents of Pyrethrum Flowers* — (i) Carotenoid pigments were isolated from pyrethrum flowers. A note on the concentration of β -carotene was published; (ii) studies in the subsidiary constituents of pyrethrum flowers, directed towards the isolation of the irritant principles, resulted in the separation of water-insoluble phenolic fractions.

6. *Emulsifiers for the Preparation of DDT Sprays* — Emulsifying compositions were evolved with Indian turpentine as one of the solvents and easily available emulsifying agents, to give 25-30 per cent stock solution of DDT. The Malaria Institute of India made use of the information.

7. *Utilization of Heavy Coal-tar Bases* — Cattle dips were prepared from different derivatives of higher coal-tar bases and tested against the common Indian tick at the Imperial Veterinary Research Institute, Izzatnagar.

OTHER PLANT PRODUCTS

1. *Herpestis monniera Brahmi* — In view of the importance of the drug in the indigenous system of medicine authentic samples of the leaves and the stems were obtained for chemical examination. Mannitol and a small amount of saponin were identified.

2. *Chemical Examination of Mango Blossoms* — Gallic acid was obtained in 8.9 per cent yield by the action of *Aspergillus niger* on aqueous extracts of mango blossoms.

3. *Studies in the Constituents of Chana & Other Indian Pulses* — Three crystalline products — Biochanin A, Biochanin B and Biochanin C — were separated from the sprouts of Bengal gram. Identical products, in a much higher yield, were separated from *Kabli chana*. Biochanin A was assigned the constitution 5, 7 dihydroxy-4-methoxy isoflavone, which has been confirmed by synthesis. Biochanin C had growth-promoting activity. The constitution of Biochanin B was studied and the results published. Investigations on the germs of *mung*, *urd*, pea and soyabean were also carried out and small quantities of crystalline products were isolated from them.

4. *Chemical Examination of Soyabean Germs* — Two crystalline isoflavones had been reported from fresh soyabean germ, one of them apparently identical with tatoin, as reported by Okarno and Beppu. In attempting a synthesis of tatoin, an isomer was obtained. A colourless crystalline, nitrogen-containing product, identified as Biochanin C was obtained, in the course of the reinvestigation of soyabean germ, in yields almost six and three times that obtained from *chana* and *Kabli chana* germs respectively. The presence of Biochanin C with growth-promoting activity partially accounts for the high nutritive value of soyabean.

5. *Chemical Investigations of Euphorbia tirucalli* — The milky juice of *E. tirucalli* coagulates rapidly to a wax-like mass. The coagulum contained: resins, 52 per cent; a crystalline compound, 24 per cent; the balance consists of a rubber-like substance, proteinous matter, etc. A crystalline substance was isolated in 5 per cent yield from the fresh latex of the plant, and this was identified as an alcohol, isomeric with euphora¹ obtained from euphoron by reduction.

6. *Utilization of Latices from Euphorbiaceae* — The resins obtained from the latices of these plants were treated with sulphur, formaldehyde, phthalic anhydride and other substances. Some of the modified resins were suitable for use in moulding powders, varnishes and plasticizers. A product which can be used as a textile auxiliary for fire-proofing and water-proofing fabrics was obtained by chlorination. The results of these investigations are protected by patents.

7. *Chemical Investigation of Gum Euphorbium* — By chromatographic separation on a column of Fullers' earth, the neutral portion of gum euphorbium was fractionated into two crystalline substances, which were found to be different from the compounds isolated from other varieties of *Euphorbia* by Newbold and Spring.

8. *Rubber from Cryptostegia grandiflora* — Investigations were undertaken at the instance of the Supply Department to find an easy workable method for extracting rubber from this plant. The methods in use for collecting the latex were cumbersome. Two processes were worked out for extracting rubber from twigs and leaves, and 90-99 per cent of the rubber present in the material could be recovered. The processes were patented.

9. *Natural Tannins* — Galls of *Tamarix gallica* and pods of *Wagatana speciosa* were found to be rich sources of tannin and could be exploited for use in leather industry.

10. *Pectin Content of Plant Materials* — Pectin content of 30 plants from Delhi were studied and pure pectin was prepared from them.

11. *Chemical Examination of Babchi* — A crystalline lactone was isolated from the pericarp of *Babchi* (*Psoralea corylifolia*) seeds and its constitution studied.

12. *Tetra-N-methyl-holarrhimine* — The constitution of tetra-N-methyl-holarrhimine was studied. A crystalline base was obtained by distillation with zinc dust. Oxidation with periodate and sulphuric acid gave a crystalline dioxy derivative, along with small quantities of a water-soluble base.

13. *Chemical Examination of Picrorhiza kurroa* — A bitter glucoside was isolated from the alcoholic extract of the drug. Cinnamic acid was identified in the glucose residue. The presence of hydroxyl, carboxyl and methoxy groups in the substance was confirmed. Hydrolysis of the glucoside with baryta or alkali yielded two crystalline aglucones, which were identical with vanillic and cinnamic acids.

14. *Chemical Investigation of Salsurea lappa* — This important drug for heart ailments is reported to contain phellandrene, castrol, costic acid and related compounds. Investigations showed that the active principle of the drug was resinous in character. The alkaloid, salsureine reported by Ghosh, Chatterjee and Dutta, was probably formed by the condensation of resinous products with ammonia during the isolation. The condensation product gave tests for alkaloids.

15. *Antibiotic Activity of Leaf Extract of Prosopis juliflora* — Antibiotic principles obtained from the aqueous and alcoholic extracts of fresh mature leaves of *P. juliflora* had marked bacterio-static activity against *Staph. aureus* and *B. coli*. The antibiotic principle was fairly stable in alcoholic solution at room temperature, but deteriorated rapidly when the solution was concentrated even *in vacuo* at 50°C. A new technique was evolved for obtaining effective concentrates of the antibiotic principle.

16. *Examination of De-fatted Chaksa Seeds* — A crystalline neutral mono-sterol product (m.p. 300°C.) was isolated from de-fatted chaksa seeds. It was insoluble in water and organic solvents (except pyridine) and

gave on analysis: C, 71.6; H, 10.45; and O, 17.25 per cent in agreement with an empirical formula C_5H_9O .

17. *Oxidation of Chaksine Nitrate with Nitric Acid*—Chaksine nitrate, when oxidized with concentrated nitric acid, gave crystalline oxidation bases. The optimum conditions for the reaction were worked out and it was found possible to obtain yields as high as 80 per cent. The main crystalline bases melting at 187° and 205°C. respectively were characterized through their various salts, such as iodide, chloride, sulphate, picrate and platinate.

VEGETABLE OILS

1. *Fatty Oils from Mimosa pudica & Sisymbrium irio*—The characteristics of the fatty oils from the seeds of the two plants were investigated and their unsaponifiable fractions examined.

2. *Fatty Oils from Mallotus philippinensis* Muell.—The drying oil from the seeds was obtained by solvent extraction and examined. Separation of the total fatty acids by the usual process was not possible as the acids tend to polymerize rapidly.

3. *Effect of Storage on Indian Vegetable Oils*—Changes in various refined vegetable oils and fats during storage in glass, tinned steel, and plain steel containers were studied. Oils in plain steel containers were rapidly discoloured and oxidized. Exposure to air has a marked influence on oil deterioration.

4. *Stabilizer for Fat used in Baking*—Fats used in baked products are prone to become rancid, the factors contributing to rancidity being baking temperature, ingredients, metallic contamination, moisture, conditions of storage, nature and quality of fat, destruction of natural anti-oxidants present during refining or inactivation during baking. A number of non-toxic anti-oxidants were found to stabilize the fat in the baked product. Wheat germ oil is the most effective for vanaspati and ghee. N.D.G.A. (Nordihydroguaiaretic acid) and soyabean lecithin come next. Vegetable oil shortening may be stabilized by kamala dye, N.D.G.A. and wheat germ oil with various synergist-like citric and tartaric acids.

5. *Chemical Examination of Cucumis sativus* Linn.—To establish the nutritional value of seed kernels of *Cucumis sativus* Linn. (natural order *Cucurbitaceae*) used in confectionery, an analysis of the seed was carried out. The seed contained oil, 42.5 per cent; protein, 41.7 per cent; and phosphate (P_2O_5), 0.62 per cent.

6. *Chemical Examination of the Drying Oil from the Seeds of Trichosanthes anguina* Linn.—Seeds of *Trichosanthes anguina* Linn. (natural order, *Cucurbitaceae*) contain c. 32 per cent of a dark reddish brown oil yielding a non-tacky soft film, when applied on glass plate with cobalt linoleate as additive. The oil had good drying properties.

7. *Chemical Examination of the Fatty Oil from the Seeds of Gmelina asiatica* Linn.—The roots of *Gmelina asiatica* Linn. (natural order, *Verbenaceae*), grown abundantly in South India, Burma and Ceylon, find use as a demulcent, alterative and in the treatment of rheumatic pains. The seeds were found to contain c. 5.5 per cent semi-drying oil.

RESINS & WAXES

1. *Chemistry & Applications of Indian Oleo-resins*—Attempts were made to work out a simple and economic method for the preparation of

l-abiatic acid from rosin under the mildest possible conditions and a method for the transformation of primary rosin acids, without any application of heat thereby ruling out the possible formation of pyroabiatic acid, was arrived at. Further evidence was brought forward against the theory of the occurrence of primary rosin acids as anhydrides.

2. *Abiatic Acid from Indian Rosin* — By progressive steam distillation of rosin at a temperature above 200°C. practically pure abiatic acid distilled over.

3. *Studies in the Chemistry of Rosin Acids of Pinus longifolia* — Possibilities of utilizing abiatic acid extracted from *Pinus longifolia*, as a starting material for the preparation of compounds closely related in structure to naturally occurring compounds of the phenanthrene group were explored and a new method of preparing 6-amino-dehydroabiatic acid in a pure form in good yields was developed. The work was extended to substitution of the carboxyl group of dehydroabiatic acid and the preparation of the following new compounds: (i) 6-bromodehydroabiaticamide, (ii) 6-bromo-dehydroabiaticamine, (iii) 6-bromo-dehydroabiaticdimethylamine, (iv) dehydroabiaticamide, (v) dehydroabiaticamine, and (vi) dimethyl-dehydroabiaticamine.

4. *Bhilawan Shell Liquid* — A number of processes were worked out for converting bhilawan shell liquid into non-vesicating, semi-solid to solid products which can be utilized in the manufacture of lacquers, varnishes, enamels, insulating materials and moulding plastics. The shell liquid was also employed for the regeneration of rubber waste to produce hard (ebonite substitute), semi-hard and soft rubber goods. Cracking of the shell liquid and subsequent fractionation of the cracked product led to the isolation of catechol, a series of unsaturated hydrocarbon and lower phenols. The phenolic constituents can be employed for the manufacture of syntans.

An improved process for the expulsion of the shell liquid, by exposing the nuts to superheated steam, resulted in the production of a shell liquid comparable to the solvent extracted material.

Bhilawan stoving enamel has been under commercial production since 1942. The enamel can be sprayed or applied with a brush by dipping to give exceptionally glossy, hard, elastic and tenacious films without the addition of any pigment or by admixture with a drying oil or resin on stoving for 2 or 3 hours. The enamel film is weather resistant and is unaffected by boiling water, organic solvents and strong acids. In addition, a whole range of other stoving enamels has been obtained by modifying bhilawan resin with certain vegetable oils, bitumen, asphalt and pitch. Air-drying varnishes in various shades and colours have been produced from resin obtained from co-polymerization of bhilawan shell liquid with easily available indigenous raw materials. One of the compositions has been found suitable as an above-ground anti-termite varnish. Various compounds have been evolved for moulding powders with resins produced from bhilawan shell liquid as binders. The moulded articles possess good heat and electrical insulation, water resistance and machinability. An ebonite substitute has been developed by regenerating hard rubber from whole tyre waste with bhilawan shell liquid.

5. *Cashew-nut Shell Liquid* — Cashew-nut shell liquid has been established in U.S.A. as a starting material of exceptional value for the plastic industry. A process for the expulsion of cashew-nut liquid was patented. To utilize the cashew-nut shell liquid a process for its conversion, in combination with varying properties of bhilawan shell liquid, into semi-solid to solid resins has been worked out and patented. The resins obtained through this process have been utilized for the production of enamels, varnishes, water proofing compositions, moulding powders, etc.

6. *Studies on the Influence of Resinols on the Viscosities of Mineral & Fatty Oils*—A systematic study of the viscosities of mixtures of cashew-nut shell liquid (whose main constituent is a long chain monohydroxy phenol) with mineral and fatty oils was carried out and viscosity values plotted against concentration of cashew-nut shell liquid. In the case of mineral oils, the viscosity decreased with increasing concentration of the shell liquid, reached a minimum value, and increased thereafter, giving a regular parabolic curve. With vegetable oils, the viscosity-concentration curve showed an opposite tendency. Similar experiments were also carried out with bhilawan shell liquid (whose main constituent, bhilawanol, contains two phenolic groups).

7. *Thermal Degradation Products from Naturally Occurring Resinols*—Investigations on the neutral fraction obtained through the thermal degradation of bhilawan have revealed that the fraction consists of a mixture of $C_{10}H_{20}$, $C_{11}H_{22}$, $C_{12}H_{24}$, $C_{13}H_{26}$ and $C_{14}H_{28}$ hydrocarbons which on oxidation yield acetic, caprylic, capric, lauric, oxalic and succinic acids.

8. *Chemotherapeutic Studies with Bhilawan*—A number of new derivatives of bhilawanol, including sulphonate, arsenic compounds, and sulphonamide derivatives have been prepared and, with the exception of the arsenic derivatives, others were free from vesicating action. Preliminary investigations on *B. coli*, *B. pyogens*, *Staphylococci*, *Streptococci* and *Pneumococci* indicated that the germicidal action of some of the derivatives was much more marked than that of bhilawanol. The arsenic derivative had a strong vesicating action on human skin but the product itself was ineffective in preventing the growth of bacteria.

9. *Tanning Materials from Bhilawan & Cashew-nut Shell Liquids*—Sulphonated products from shell liquids, after condensation with formaldehyde, could be used alone or in conjunction with vegetable tan stuffs, for tanning hides. The results showed that suitable products from shell liquids were obtained only when both sulphonation and condensation were carried out with incorporation of thermal degradation products or lower phenols like cresylic acid in certain proportions, but the thermal degradation products of shell liquids can be utilized as such. The leather obtained by the use of cashew-nut syntans was harsher than that obtained by the use of the corresponding bhilawan products.

10. *Chlorination of Rubber*—A method for the production of chlorinated rubber by chlorinating a 20 per cent solution of partially cyclised rubber was developed and patented. Transparent sheets, laminated products, water-proof cloth, etc., were prepared from this product.

11. *Cyclisation of Rubber*—Investigations on new cyclisation processes and new cyclising agents have shown that sodium thiosulphate was a good but mild cycliser. Partial cyclisation was carried out with phenol and sulphuric acid in much smaller amounts than usual. The process was patented.

12. *Castor Oil, Sebacic Acid & Nylon Type Resins*—Castor oil was degraded into sebacic acid and condensed with glycerol to give resinous products, their nature and use depending upon the degree of polymerization. Octyl alcohol, another byproduct of castor oil degradation, was used in the preparation of octyl sebacate, a plasticizer. Octylphenol, which is considered to be a very desirable ingredient for certain thermosetting resins, was also prepared.

13. *Optimum Conditions for the Preparation of Sebacic Acid & Octyl Alcohol from Castor Oil*—The oily sludge, obtained in the preparation of sebacic acid, was investigated with a view to utilizing it as plasticizer or as surface active reagent.

14. *Investigations on Castor Seed Lipase* — The nature, mode of action, and industrial utilization of castor seed lipase were studied. Conditions for the stability and optimum activity of the enzyme were determined and methods of preparing highly active dry powders were worked out. In the dry fat-free form, the enzyme was more sensitive to alcohol than to acetone.

15. *Chemical Analysis of De-gelled Castor Oil* — With a view to extending the uses for de-gelled castor oil, metallic salts of the constituent acid alkyl resins, etc., were prepared.

16. *Chlorinated Waxes from Naphthalene* — In view of the availability of naphthalene and the wide range of its industrial applications, processes were worked out for the preparation of chlorinated naphthalenes. It was observed that more chlorine was absorbed in a discontinuous cycle than in a continuous cycle, and anhydrous ferric chloride was found to be the best catalyst. Naphthalene in the fused state should be used in preference to naphthalene solution. The black chlorinated product gave light yellow waxes when distilled in vacuum.

BIOCHEMICAL RESEARCH

1. *Nutritive Requirements of Yeast & the Production of Potent Yeast Strains* — Two types of *Saccharomyces cerevisiae* and two of *Torula utilis* were studied with respect to their carbon, nitrogen, mineral and vitamin requirements. An optimum concentration for each of the vitamins studied namely thiamin, nicotinic acid and riboflavin was observed. Based on this work, a simple method for the estimation of thiamin was worked out, using an adapted strain of *Torula utilis*.

Work on the manufacture of food yeast was undertaken on a pilot plant scale.

2. *Studies on Ascorbic Acid* — The concentrations of free, dehydro and combined ascorbic acid in a large number of plants were determined. The factors influencing the biosynthesis of ascorbic acid in germinating seedlings were also investigated.

Determination of the plasma concentration of ascorbic acid was carried out along with other clinical elements such as haemoglobin, erythrocyte counts, blood urea, blood sedimentation rate, etc. Ascorbic acid was found to influence the blood urea sedimentation rate directly. The therapeutic effect of ascorbic acid in tuberculosis was also studied.

3. *Studies on Extraction of Ascorbic Acid* —

(i) Experiments on extraction of ascorbic acid from plants were carried out and oxalic was found to be a good extractant.

(ii) Synthesis of ascorbic acid by germination of cereals and the effect of sunlight and manganese on the process was investigated. The results were published.

4. *Growth-promoting Factor in Bengal Gram* — Investigations were initiated on albino rats receiving a basal diet containing all the known nutritional factors to which were added supplements of various fractions of germinating Bengal gram. In preliminary experiments the germ, alcoholic extract of the germ and Biochanin C gave positive results indicating the presence of a new growth-promoting factor in the germ. The effect of Biochanin C on the growth of simple plant bodies like yeast (*Saccharomyces cerevisiae* and *Torula utilis*) and *Penicillium notatum* (Flaming) has also been studied and a 100 per cent increase in the growth of yeast was recorded. In the case of *Penicillium notatum* the increase is

30 per cent but the amount of penicillin produced was not affected. From the experiments conducted Biochanin C was shown to possess a definite growth-promoting activity and improvement in growth produced by it was additional to the effect of Vitamin B.

5. *Synthesis of 7-Hydroxy, 4-Methoxy, 6-Methyl & 7-4-Dihydroxy & 6-Methyl Isoflavones* — A colourless crystalline compound, containing products similar to Biochanin C, was isolated by the treatment of soyabean germ and five new isoflavones, including isotatoin, were synthesized. Synthesis of monomethyl genistein, an isomer of the natural isoflavones prunetin, prunesetin and Biochanin A also threw some light on the constitution of prunetin and prunesetin.

6. *Carotenoid Pigments & Vitamin A Potency of Plants* — A series of investigations on the carotenoid pigments of common edible plant tissues, involving the method of chromatographic separation, colorimetric estimation and identification by their absorption spectra and other physical properties were initiated. The quantities and characteristics of the pigments present variation from species to species and their vitamin A potency also varies. Investigations on the metabolism of carotenoids in developing plant tissues, the phenomenon of isomerization, occurrence and formation of the more important pigments were studied. Provitamin A activities of neo- β -carotene B and neo- β -carotene U were observed. In the course of a study of the development of carotenoid pigments during ripening, it was found that all carotenoid pigments increase in the case of mangoes but decrease in leafy vegetables. β -carotene content of tomatoes was hardly influenced by environmental conditions. Plasmolysin as a means of liberating carotenoid pigments from leaves was also investigated. Carotenoid was extracted to the extent of 25-30 per cent by this method.

7. *Antibiotic Activity of a Strain of Bacillus from Vulture* — In view of its food, habits and longevity the bacterial flora of vulture was studied. During the study of aerobic bacterial flora, a strain of bacillus showed a marked tendency of overgrowing other strains. The seitz filtered broth exhibited strong antibiotic activity against *Staphylococcus aureus*. A crystalline product showing positive activity was isolated.

SYNTHETIC CHEMISTRY

1. *Synthesis of new 3-Phenyl Coumarines & Studies on Their Haemostatic Property* — High haemostatic activity was shown by some of the new synthetic 3-phenyl coumarines. Experiments were carried out to study the effect of orientation of different groups in 3-phenyl coumarines on their fluorescence and haemostatic activity.

2. *Preparation of Possible Anti-tubercular Compounds* — Investigations were undertaken to correlate anti-tubercular activity of some synthetic compounds with their chemical constitution. Starting with dichlorodiphenyl trichloroethane (DDT) and diphenyltrichloroethane, products similar to p-p' diaminodiphenyltrichloroethane, a potential anti-tubercular agent, were obtained. p-p' Dichloro-m-diamino diphenyl trichloroethane and its corresponding dialkyl (methyl, ethyl, iso-propyl and n-butyl) amino compounds were synthesized. Diquinoline derivative of trichloroethane was also synthesized.

3. *Chemical Examination of Alangium lamarkii* — *Alangium lamarkii* was reported to contain a sterol, alengol $C_{30}H_{48}O_3$ or $C_{30}H_{50}O_3$, which

showed the presence of four double bonds and three active H atoms in the molecule. Later, another sterol, named as alangol, $C_{42}H_{72}O_2$, containing one OH group was isolated from the seeds. No indication could be obtained about the nature of the remaining atoms of oxygen. Attempts were also made to isolate the alkaloidal constituents of the seeds and a white colourless base was obtained after purification with organic solvent.

4. *Studies in Hydrobenzoquinolines* — In view of their various useful properties, the synthesis of aromatic benzoquinoline derivatives was carried out. Ar-tetra hydro- α -naphthylamine was condensed with acetic anhydride and the liquid product obtained cyclised. A crystalline product (m.p. 297–98°C.) insoluble in most solvents but soluble in alcohol, 7, 8, 9, 10-tetrahydro-2-methyl-4-hydro-oxybenzo-quinoline and its hydrochloride were prepared. Other derivatives were also synthesized.

ORGANIC CHEMICALS

1. *Citric Acid from Citrus Fruits* — Citric acid was obtained from Assam and Bengal lemons but on account of high cost, the possibility of commercial manufacture was precluded except with lemons from Bihar.

2. *Agar Agar* — It has been shown that *Gracilaria lichinoides* obtained from Travancore is sufficiently rich in agar agar to form an economic raw material for its large-scale production in India. A new and inexpensive method was worked out for the purification of *Gracilaria lichinoides* from Travancore and to obtain bacto-agar of B.P. and U.S.P. quality.

3. *Furfural* — Furfural was obtained from rice bran, maize bran, rice husk, bagasse, paddy straw and corn cobs. The economics of the process were also studied.

4. *Phthalic Anhydride* — A pilot plant for production of phthalic anhydride by controlled oxidation of naphthalene was developed for the *Shalimar Tar Products (India) Ltd.*, and optimum conditions for its working were determined.

5. *Vapour Phase Oxidation of Indian Turpentine* — An apparatus and technique for carrying out catalytic vapour phase oxidation of Indian turpentine and its various fractions was developed. Work to increase the yield and to determine the nature of oxidation was also carried out.

INORGANIC CHEMICALS

1. *Manufacture of Soluble Barium Salts from Barytes* — The preparation of barium chloride was effected commercially by evolving a new method which was adopted on a large scale by Messrs *Mettur Chemical & Industrial Corporation*, Mettur (S. India). Barium chloride of 99.94 per cent purity was obtained, 190 lb. of sulphur per ton of barium chloride being produced as a byproduct.

2. *Recovery of Titanium Dioxide from Bauxite Sludge* — The general principles underlying the manufacture of titanium dioxide were re-investigated to determine the optimum conditions and a pilot plant with a production capacity of 20 lb. of titanium dioxide per day was designed, constructed and tried. Titanium dioxide of very high purity (99.56 per cent) and fairly good pigmentation properties were recovered.

3. *Ammonium Nitrate* — At the instance of the Master General of Ordnance, the manufacture of ammonium nitrate was investigated. It

was found that the reaction does not proceed strictly in accordance with the simple chemical equation governing reactions, between ammonium sulphate and potassium nitrate and fractional crystallization as such could not effect complete separation of the two salts. Better yields could be obtained by increasing the concentration of ammonium ion in the reacting solution.

4. *Zinc Sulphate & Zinc Oxide* — Zinc slime, a waste byproduct in brass foundries, was converted into the sulphate by treatment with sulphuric acid. Iron was removed by electrolytic precipitation by another metal higher in the electrochemical series. The zinc sulphate thus obtained was chemically pure. Zinc oxide was prepared from this first by precipitation as zinc carbonate and then decomposing the carbonate into zinc oxide.

5. *Vanadium Compounds* — Vanadium ore was finely powdered, mixed with sodium chloride in excess and roasted at controlled temperatures for a specified time. The roasted material was extracted with water and crude ammonium vanadate recovered by saturating the lixiviated liquor with ammonium chloride. If the roasting is carried out under slight oxidizing conditions by using a small amount of potassium nitrate, a great improvement in the yield of vanadium salts is obtained.

6. *Utilization of Sodium Sulphate* — *A Byproduct of Dichromate Industry* — A method for purifying the sodium sulphate obtained as a byproduct in the manufacture of dichromate and rendering it chromium free was developed.

7. *Purification of Borax* — Methods were evolved for purifying borax from Jagadhri (Punjab).

8. *Ultramarine Blue* — Use of indigenously occurring bentonite, kaolin and other earths for manufacture of ultramarine blue was investigated.

MISCELLANEOUS INVESTIGATIONS

1. *Air Foam Solutions* — Supplies of imported foam solution which is indispensable for protecting oil installations and putting off fires were cut off during war time. Investigations were undertaken to produce the material from indigenous sources. Degradation products of proteinous matter were found to give the maximum amount of foam. Degradation was carried out under controlled conditions, the resulting hydrolysed solution concentrated and sterilized. The process was patented and leased out for commercial exploitation besides free permission being accorded to several oil companies to manufacture the foam for use at their own installations. More than a lakh gallons of the material were manufactured to meet defence requirements.

2. *Tin-lining Compounds* — Investigations led to the formulation of a compounded latex containing 25-30 per cent fillers which gives a tough elastic film inert to vegetable ghee and meets the other requirements of tin-lining compounds. The formula was released for large-scale production to a firm in Delhi.

3. *Anti-scatter Treatment for Glass* — Investigations were undertaken with the object of giving anti-scatter treatment to glass to prevent the falling or flying off of broken glass fragments due to blasts created by explosion of high explosive bombs. Adhesives prepared from gum arabic and glycerol preserved with commercial phenol or cresol gave good results

for pasting paper while a composition prepared from chlorinated rubber showed satisfactory results for pasting textiles.

4. *Modified Coal-tar Pitch*—Due to shortage of bitumen, attempts were made to modify the properties of coal-tar pitch suitably to replace bitumen specially in the manufacture of roofing felt, roofing pitch and plastics. Medium hard coal-tar pitch was blown with air at elevated temperatures in the presence of catalysts and plasticizers and compounded with fillers. Satisfactory outdoor exposure test results were obtained with samples of roofing pitch. Pitches were also prepared for the manufacture of roofing paper, roofing felt, etc.

5. *Examination & Utilization of Wood Tar*—Wood tar obtained from Messrs Fertilizer & Chemicals Ltd., Travancore, during manufacture of producer gas by distillation of wood was examined. This tar on distillation yields 44 per cent of an oily liquid leaving 38 per cent pitch. Utilization of this oily distillate in the preparation of varnishes was investigated.

6. *Use of Indigenous Micaceous Iron Ore as Pigment*—A method to purify micaceous iron ore and make it suitable for use in paints was developed. Panels prepared from these paints were subjected to natural and accelerated artificial weather tests.

7. *Aeroplane Dopes*—Nitro-cellulose lacquers, which are used as aeroplane dopes, were prepared from waste film dissolved in power alcohol containing a plasticizer and a synthetic resin. Tests at the Ordnance Laboratories, Kanpur, and the Government Test House, Calcutta, proved satisfactory and the dope gave satisfaction even after 150 flying hours test. The process was released for commercial exploitation.

8. *Groundnut Products*—Sulphonated products from groundnut oil-castor oil mixture, with or without the addition of cashew-nut and bhilawan shell liquids, were noted to have an important application in the fat-liquoring of leather; they can be used directly with the advantage that the treated leather has a higher tensile strength and finer feel. Groundnut oil was co-polymerized with bhilawan shell liquid and turpentine resulting in the production of a valuable resin. A modified resin was also prepared by incorporating another resin in the process of co-polymerization. The co-polymers form a soft semi-solid to solid mass soluble in benzene, turpentine and white spirit yielding a varnish. The resin is also useful for water-proofing textile fabrics. The varnish was found to be useful for imparting a leather or wrinkle finish to textiles. When mixed with nitro-cellulose in suitable solvents, groundnut-bhilawan varnish yields a lacquer which has good adhesion, gloss and scratch hardness and a supple feel when coated on leather.

9. *Groundnut Protein or Defatted Meal as Plastic Material*—Brittle, brown and translucent articles were formed from groundnut protein and defatted meal by moulding under suitable conditions. The protein has a high rate of water absorption and its improvement by adding resin, aniline and shellac was investigated. Glutination of the meal prior to moulding improved the flow and finish of moulded pieces, but water absorption was not much reduced.

10. *Cracking of Groundnut Oil*—Calcium oxide gave higher yield of cracked products of groundnut oil with maximum amount of low-boiling fractions, both for bulk or instantaneous cracking. Several Twitchell type reagents using cashew-nut shell liquid, bhilawan shell liquid, rosin oil etc. were prepared and their efficiencies as fat splitting reagents were studied.

11. *Salad Oil*—A process was developed for treating groundnut oil with high temperature steam under certain experimental conditions to

give a nearly neutral clarified oil, free from the characteristic groundnut oil odour.

12. *Lignite Coal* — A resin was obtained by solvent extraction of lignite from Bikaner State and utilized for production of plastics and varnishes. A moulding powder with good surface finish, tensile strength and flow was formulated by employing the extracted resin in combination with depolymerized lac and jute and other agricultural wastes as fillers. In combination with drying oils the lignite resin was used for preparation of water and gas-proof varnishes. A dope which renders the cloth used for balloons hydrogen-proof was also prepared from the resin. The reports of tests carried out at the American Air Headquarters, Agra, at whose instance the investigation was carried out, were very favourable. The de-waxed and de-resinified lignite with 5 per cent pitch or bitumen as binder yields briquettes.

13. *Fluxes for Welding Aluminium* — In view of general scarcity of cryolite and other fluorides, investigations were undertaken to develop a flux composition from entirely indigenous raw materials and having comparable welding characteristics. Samples from the new flux were in no way inferior to imported fluxes. The process was patented.

14. *Signal Smokes & Flares* — At the instance of the M.G.O. and Civil Defence Departments, successful formulae were evolved for yellow, red and blue non-toxic smokes possessing high density, low rate of burning and pronounced colour and stability. The formulae were revealed to contractors to meet government requirements.

15. *Transparent Papers* — Investigations on the manufacture of continuous films of cellulose were undertaken at the instance of the R.A.F. who required transparent tapes, 3 in. wide and 300 ft. in length, from salvaged wind screens of aeroplanes. A pilot plant to produce films of different thicknesses required was constructed. The plant could also be used for producing cinematograph films and cellophane papers from various resin solutions.

16. *Cork Substitutes* — Waste from rejected bamboo strainers after a preliminary treatment and mixing with binders like blown linseed oil or castor oil and fillers gives flexible but tough, and weather resistant products possessing the characteristics required for cork substitutes. The process was covered by a patent.

17. *Shock-resistant Packing Material* — The experience acquired in the development of cork substitutes was utilized in making sponge-like products and flexible sheets of varying porosity. Stiffer varieties were used as packing material while another variety evolved using animal hair with rubber binders proved to be of use where resistance to shock is required. It is light, flexible and springy. Animal hair could be substituted by coir fibre without impairing the qualities of the products. The process was patented.

18. *Sintered Glass* — In view of the ever widening application of sintered glass, both in the laboratory and industry, experiments were undertaken to manufacture them from resistance glass made in India. Articles of different shapes—flat, concave, and convex—thimbles, crucibles, pots, etc., of different porosities can be made by this process which has been covered by a patent.

19. *Water & Grease-proof Paper* — Samples of butter and wrapping paper for general use were made and tested at the Central Food Laboratories, Kasauli, and found satisfactory. The process was patented.

20. *Water & Fire-proof Cloth* — After extensive investigations a composition based on the use of chlorinated products from indigenous resins

for making cloth non-inflammable and water resistant was developed and patented.

21. *Hydraulic Fluids* — Fluids for use in hydraulic mechanisms were developed from refined castor oil with the addition of small amounts of stabilizers and other ingredients. The patented process was leased out.

22. *Thickened Fuel for Flame Throwers* — To replace aluminium stearate used to thicken the fuel in incendiary bombs, substitute soaps were prepared and conditions for their large-scale production standardized. Substitutes for phenolic bodies which are the other main constituents of these bombs were also developed from bhilawan shell liquid and cashew-nut shell liquid. The results of the investigations were made available to the Supply Development Committee.

23. *Water-detecting Composition* — A composition for detecting water in petrol containers was produced and was found to be much superior to the imported product. It can be employed for detecting the depth of water below petrol, vegetable oils, heavy machinery or lubricating oils, hydrocarbons, etc. A patent embodying the results of the investigations was taken out and the development of the process was entrusted to the Supply Development Committee.

24. *Sizing Material from Mango Seed Kernels* — Mango seed kernels were found to yield an appreciable proportion of starch and could be utilized as a rich source of sizing materials.

Researches Sponsored by Industry

In addition to the researches financed by the Council, several problems of direct concern to industries were investigated in the D.S.I.R.'s Laboratories at the instance of the concerns, the expenditure involved being borne by the industries themselves. A brief account of the results obtained under these schemes is given below.

UTILIZATION OF PARAFFIN WAX (*Steel Bros. Co. Ltd.*)

A process was developed for the catalytic oxidation of waxes to acids and aldehydes. The products find important applications as rot-proofing agents and as detergents.

Water-proofing compositions for canvas were obtained by emulsifying wax with latex. The addition of suitable insecticides to the emulsions rendered them useful as mildew preventives.

POUR POINT DEPRESSANTS (*Steel Bros. Co. Ltd.*)

Pour point depressants are added to lubricating oils to lower their congealing points. Lubricating oils produced from Burma crude oils have appreciably high pour points on account of their high wax content. A product obtained by processing natural hydrocarbons had properties comparable to Parafflow, the standard imported pour point depressant.

DE-EMULSIFIERS (*Steel Bros. Co. Ltd.*)

Crude oils form obstinate emulsions with water which are difficult to break. Proprietary products such as Icipol and Separator W used for de-emulsification were difficult to obtain during the war period. Substitutes had to be found, and compositions formulated from vegetable oil soaps were found to be satisfactory. Samples were sent to *Attock Oil Co.* for practical tests.

SUBSTITUTES FOR GLASS (*Steel Bros. Co. Ltd.*)

Shatter-proof substitutes are used in place of glass for safety in situations exposed to aerial bombing and shelling. The materials should be translucent, flexible and resistant to high wind pressure. A thin film of plastic material spread over wire gauze usually serves the purpose. After exhaustive trials with various plastics and resins, a suitable substitute was produced using indigenous ingredients. Due to the difficulty in obtaining wire gauze, an attempt was made to produce dopes for impregnating cloth and render it translucent. A process was developed for producing dopes from vegetable oil derivatives. Commercial production was undertaken by *Indian Glass Substitutes Co.*, Simbhaoli, and approximately 2.5 million sq. ft. glass substitute were produced during the war period.

SEAMING VARNISH (*Steel Bros. Co. Ltd.*)

An off shoot of the research on glass substitutes was the production of a seaming varnish for anti-gas cloth. The varnish was required for sealing holes in sewn garments. The composition developed in the laboratory was tested in the Ordnance Laboratory, Kanpur, and found to be satisfactory. Large quantities of the varnish were prepared and supplied to meet defence requirements.

PETROL-PROOF CANVAS BAGS (*Steel Bros. Co. Ltd.*)

Canvas bags for holding petrol were rendered leak-proof by the application of resinous coating on the surface of bags. A formula for the preparation of coating compositions was worked out.

VEGETABLE OIL LUBRICANTS (*Steel Bros. Co. Ltd.*)

Investigations were undertaken to find the possibilities of blending mineral and vegetable oils for use as lubricants. Several blends were prepared — light machine oil, spindle oil, oil for use in card and comb boxes and spinning and weaving mills, and oils for bearings of electrical motors, shafting and dynamos. The blends were tested by *Messrs Burmah-Shell Co.* in different mills. The blends compared favourably with straight mineral lubricating oils and were entirely satisfactory. Further investigations revealed that blends of castor, rape, and groundnut oils with mineral oils yield good results in the lubrication of textile machinery, except when the bearings were composed of brass. A suitable addition for minimizing the action on brass was developed.

LUBRICANTS FOR LEAD-BRONZE BEARINGS (*Steel Bros. Co. Ltd.*)

Indigenous vegetable oils were processed to bring them to the required viscosity and blended with vegetable oils. The blends were tested by the railway department and found suitable.

ACTION OF HIGH TENSION ELECTRICAL DISCHARGE ON OILS
(*Steel Bros. Co. Ltd.*)

Under the action of electric discharge light mineral oils underwent cracking and yielded lighter fractions, while heavy mineral oils were polymerized to yield lubricants which were lighter in colour and possessed better lubricating properties. Vegetable oils yielded heavy oils under this treatment which could be used as lubricants.

SOLUBLE OILS (*Steel Bros. Co. Ltd.*)

An oil, easily emulsifiable with water, was prepared from castor oil, and emulsifying agents for use as "cutting" oil and for other purposes were also prepared.

DRYING OILS (*Steel Bros. Co. Ltd.*)

A tung oil substitute, for use in paints and varnishes, was obtained by the dehydration of castor oil with the help of catalytic agents. A semi-commercial plant was put into production. A light coloured oil was obtained by heating the oil in vacuum.

HYDROCARBONS FROM VEGETABLE OILS (*Steel Bros. Co. Ltd.*)

Crude oil was obtained in 50 per cent yield by cracking lime soap of *mohua* oil. The crude oil was fractionated into three fractions, namely (a) 25 per cent boiling in the petrol range, which turned dark on standing and had a low octane value, (b) 50 per cent boiling in the kerosene range, green in colour and giving a white luminous flame, and (c) a black oil residue which could be used as diesel fuel. The crude oil deposits a wax (m.p. 77°C.) on cooling.

By straight cracking of *mohua* oil, a foul-smelling acidic distillate, having a pungent, irritating smell, was obtained. A foul-smelling alkaline distillate, soluble in water, was obtained by cracking groundnut oil cake.

BITUMEN PRODUCTS — WOOD PRESERVATIVES (*Steel Bros. Co. Ltd.*)

Mixtures of emulsions containing bitumen are used for the rot-proofing of wood. Suitable compositions were formulated with fuel oil, and insecticides (prepared from petroleum or from vegetable oil derivatives) were incorporated to render them effective as rot-proofing agents.

OBSCURATION CLOTH (*Steel Bros. Co. Ltd.*)

Opaque and water-proof cloth was prepared by applying suitable bitumen composition on cheap fabric base. The product which was flexible and non-tacky could be used as a black-out material. Samples produced were approved by the Supply Development Committee.

ANTI-FROTH COMPOUND (*Steel Bros. Co. Ltd.*)

An effective agent for preventing the frothing of glue was developed from indigenous materials. Trials showed that it was comparable in its effectiveness to imported soap used by the cine film industry for suppressing frothing.

ROT-PROOFING OF SAND BAGS (*Steel Bros. Co. Ltd.*)

The investigation was started at the suggestion of the Supply Development Committee. Starting with brass scrap, an effective rot-proofing agent for fabrics was developed.

CANVAS WATER CONTAINERS (*Steel Bros. Co. Ltd.*)

Experimental proofings of canvas water containers were carried out at the instance of the Supply Development Committee for field service trials. Suitable compositions containing bituminous materials were formulated.

LEATHER DRESSINGS (*Steel Bros. Co. Ltd.*)

Substitutes for imported leather dressings were prepared from indigenous materials.

BOOT POLISH (*Steel Bros. Co. Ltd.*)

A satisfactory formula for high grade boot polish based on indigenous material was developed.

SUBSTITUTE FOR ROOFING FELT (*Steel Bros. Co. Ltd.*)

Hessian treated with coal-tar pitch and fillers gave a satisfactory material for weather-proofing.

DECOLOURIZING EARTH (*Steel Bros. Co. Ltd.*)

Kashmir bentonite was processed to yield an activated earth with good bleaching properties. Scarcity of plant and sulphuric acid delayed the large-scale utilization of the process. Bauxite and Fullers' earth did not respond to the treatment.

BRIQUETTES (*Steel Bros. Co. Ltd.*)

Using a cheap binding material, waste paddy husk was converted into briquettes.

FORTIFICATION OF VANASPATI WITH VITAMINS
(*Ganesh Flour Mills, Delhi*)

Attempts were made to prepare vitamin A concentrates from inexpensive natural materials. A number of leafy vegetables, rich in carotene, were investigated. The products obtained imparted a greenish shade to vanaspati, and a persistent odour, both of which were objectionable. Further investigations were undertaken to overcome these defects.

FLAVOURING OF VANASPATI (*Ganesh Flour Mills, Delhi*)

The substance responsible for the flavour in butter or cream is diacetyl, produced by the action of certain bacteria on acetyl-methyl carbinol. Processing of vanaspati, after the addition of "starters", gave a product with ghee flavour. Attempts were made to extract the flavouring principle from butter-milk. A combined fermentation and solvent action method was developed, and a concentrate containing the principle was prepared. The quantity of the flavouring material present in the concentrate, however, was too low to be of practical value.

An attempt was made to prepare artificial blends from commercial flavouring materials to simulate diacetyl.

FISH OIL AS A SOURCE OF VITAMINS (*Ganesh Flour Mills, Delhi*)

Large quantities of fish oil are wasted in the process of fish drying. The oil can be collected, purified and standardized for use as sources of vitamins A and D. Cholesterol can also be collected and irradiated to give vitamin D. Besides the oil, 5-8 per cent of stearin, which is commercially utilized in making boot polishes and candles, can be recovered. Investigation on this subject yielded useful results.

VITAMIN A FROM PLANKTON (*Ganesh Flour Mills, Delhi*)

Investigations on plankton collected from Madras coast showed that a viscous oily material (yield, 2-3 per cent) containing vitamin A could be obtained by solvent extraction. The residue left after the extraction of fatty matter was rich in assimilable nitrogenous materials and could be utilized in food preparations.

VITAMIN C (*Ganesh Flour Mills, Delhi*)

Vitamin C was extracted from amla (*Phyllanthus emblica*) and adsorbed on kaolin. Using the adsorbed vitamin, tablets (0.5-1 gm.) containing 1 to 2 mg. of vitamin C were prepared.

UTILIZATION OF BAGASSE (*Khatauli Sugar Works*)

By subjecting bagasse to steam under pressure, the fibres were rendered soft and the treated material moulded into boards without addition of any resin. Investigations were carried out to determine the conditions for producing wood substitutes from bagasse, which combine the tensile strength of wood and the water resistance of bakelite. The boards produced had high impact and tensile strengths and high resistivity.

BAGASSE RESIN (*Khatauli Sugar Works*)

Bagasse resin extracted with spirit is a dark brown lustrous solid, soluble in alcohol and aniline, but insoluble in benzene and in vegetable and mineral oils. It has good binding and water-proofing qualities. Moulding powders containing the resin are well adapted for the manufacture of flat articles. The resin could be used in water-proofing compositions and in spirit varnishes, paints and lacquers. A patent covering this investigation has been sealed.

INVESTIGATIONS ON INDIAN TURPENTINE (*Jallo Rosin Co.*)

Several projects were sponsored by *Messrs Jallo Rosin Co. Ltd.* and investigated in the D.S.I.R.'s Laboratories. Mention may be made of the following: Production of anti-knock dopes; conversion of low grade turpentine to resin; manufacture of turpentine substitute for use as plasticizer; and decolourizing rosin. A pilot plant for the distillation of rosin was developed and fabricated.

UTILIZATION OF COAL-TAR PRODUCTS (*Shalimar Tar Products Ltd.*)

A process for the production of phthalic anhydride from naphthalene was developed. The commercial possibility of the process was proved by pilot plant trials.

ANALYTICAL & TESTING WORK

A large variety of store materials were referred to the Council Laboratories for testing and analysis. Materials salvaged from enemy planes, and materials designed to meet special needs were also submitted to the Council for investigation and report. The following may be mentioned: Bearing metals; aluminium casts, sheets or powders; solders; colloidal graphite; deposits from engines; oil from engines; pitch; duplicating paper; asbestos; cork coating compositions; sulphuric acid; potassium cyanide; water; standard colour identification medium; starch; chromic acid; paraffin wax; glycerine; ethylene glycol; water clarifying powder; soldering flux; desalting permutit; chloramine.

Investigations were undertaken on rust prevention of cartridge metal links, distillation characteristics of petrol, and detection of carbon monoxide in aeroplane cock-pits.

IV

NATIONAL LABORATORIES

RESearch planning and research organization had received little attention before the establishment of the Board of Scientific & Industrial Research. Although occupied with emergency problems connected with the war effort, the Board, after its inception in 1940, devoted attention to the survey of facilities for research in various fields and the formulation of operative measures for the expansion of scientific research on a scale commensurate with national needs. The inadequacy of the existing facilities and the need for establishing new laboratories were stressed by the Director, Scientific & Industrial Research, in a note submitted to the Government in September 1941. He pointed out: "The present laboratory which has been placed at the disposal of the Director, Scientific & Industrial Research, deals with physico-chemical investigations on industrial subjects and is extremely unsatisfactory from the point of view of both equipment and staff."

"I am definitely of the opinion that as time rolls by, we shall have to expand these activities considerably and these laboratories will have to be strengthened and developed on the same lines as in England. All the laboratories will be under independent directors of research and the co-ordinating authority for all scientific work under the Board should be the Director, Scientific & Industrial Research. If that happens, it would be advantageous to divide the laboratories into (a) the National Chemical Laboratory and (b) the National Physical Laboratory, under two separate Directors of Research. I have therefore thought of a plan by which the contemplated project can be given effect to gradually." This note constitutes the genesis of the national laboratories.

The Council of Scientific & Industrial Research was established in 1942 with functions including "the establishment, maintenance and management of laboratories, workshops, institutions and organizations to further scientific and industrial research". The proposal for establishing the National Physical Laboratory and the National Chemical Laboratory was accepted in the beginning of 1943, and planning committees (one for each laboratory) with Sir Ghulam Mohammed and Sir Ardeshir Dalal as chairmen were appointed to work out the details. The need for creating research facilities in specific fields, where such facilities were lacking, had still to be met. Some of the Research Committees of the Board of Scientific & Industrial Research, particularly those concerned with metals, glass and fuel, had surveyed the facilities for research in these subjects and had come to the conclusion that if research in these fields was to make a substantial headway and contribute effectively to industrial development, the establishment of specialized institutions was essential.

A Chain of Research Institutions

The Government of India announced in 1944 financial assistance for the construction and equipment of glass and fuel research laboratories.

and for general planning of other institutions". In his budget speech to the Central Legislative Assembly (29 February 1944), the Hon'ble Finance Member said: "The Council of Scientific & Industrial Research has done valuable work within the limits of funds allotted to it by Government, and the Government of India have now agreed to the Council drawing up plans for a co-ordinated scheme for the advancement of research on the assumption that Rs. 1 crore will be forthcoming towards capital expenditure on a chain of research institutions. The institutions in contemplation, in addition to the two I have mentioned, are a National Physical Laboratory, a National Chemical Laboratory and a National Metallurgical Laboratory. The balance of Rs. 1 crore will be spread over a period of three or four years after the cessation of hostilities." Support for the Council's plans was also received from private enterprise. The *Tata Trust* made a munificent donation of Rs. 20 lakhs towards the establishment of the National Chemical and Metallurgical Laboratories. *Messrs Indian Wire & Wire Products Ltd.* donated Rs. 1 lakh. Thus with funds made available by the Government and with increasing support from industry, the Council was enabled to embark on its constructive activities. Plans for the establishment of the National Metallurgical Laboratory at Jamshedpur, the Fuel Research Institute at Jealgora, and the Glass & Ceramic Research Institute at Calcutta were prepared and accepted by the Government.

In December 1943, the Governing Body of the Council appointed a Research Planning Committee, with Sir R. K. Shanmukham Chetty as chairman, "to make a survey of the existing facilities for scientific and industrial research in India... and to report on steps as may be taken towards furthering scientific and industrial research in post-war India". The report of the Committee was submitted to the Governing Body in February 1945. The report stressed the inadequacy of research facilities in India. "Research activity in India", the report pointed out, "does not represent even the bare minimum whether judged by international standards or the actual requirements of the country in her present state of industrial development... The need for research is felt not only for facilitating an adjustment to post-war conditions but also for promoting the general cause of industrialization at a time which will be rendered much more difficult by the forces of international competition." The report welcomed the Council's proposals for the establishment of national laboratories and recommended that, in addition to those already contemplated, special laboratories should be set up for food technology, leather research, building and road research, electro-chemistry, oil and paint technology and industrial fermentation.

A Great & Historic Step

The real development programme of the Council began only after the attainment of independence. The establishment of the National Government in 1947 provided the "climate" for the fruition of plans which the Council had prepared for the advancement of scientific research in the country. Science in India received the recognition and importance due to it, and a Department of Scientific Research was created under the direct charge of the Prime Minister. The plans of the Council were welcomed by State Governments and lands and buildings were made available for the location and housing of the national laboratories.

Further donations were received from leaders of industry. Building construction, laboratory equipment and recruitment of staff were taken up concurrently. The year 1950 saw the opening of six national laboratories — the National Chemical Laboratory, Poona (3 January 1950), the National Physical Laboratory, New Delhi (21 January 1950), the Fuel Research Institute, Jealgora (22 April 1950), the Central Glass & Ceramic Research Institute, Calcutta (26 August 1950), the Central Food Technological Research Institute, Mysore (21 October 1950) and the National Metallurgical Laboratory, Jamshedpur (26 November 1950). The Central Drug Research Institute, Lucknow, was opened on 17 February 1951 and the Central Road Research Institute, Delhi, on 16 July 1952. The other three laboratories in the chain were opened in the early months of 1953 — the Central Electro-Chemical Research Institute, Karaikudi, on 14 January 1953, the Central Leather Research Institute, Madras, on 15 January 1953 and the Central Building Research Institute, Roorkee, on 12 April 1953.

The establishment, maintenance and management of laboratories for furthering scientific and industrial research is a continuing function of the Council. In his address at the opening of the Central Building Research Institute (12 April 1953), the Prime Minister observed: "The completion of the chain of eleven national laboratories, the map of which we made a few years ago, is, to my mind, a very great and historic step in the advancement of our country". He added: "Of course, we shall have more research institutes and more laboratories. In fact, some are actually under contemplation..." The Central Salt Research Station, at Bhavnagar, has already started working. The foundation-stone of the Central Electronics Engineering Research Institute was laid on 21 September 1953 at Pilani and planning of this institute and of the Mechanical Engineering Institute at Calcutta has been taken on hand. A National Botanical Garden has been established at Lucknow.

Location, Scope & Functions

The Council's laboratories are distributed all over the country, from Karaikudi in the south to Roorkee in the north and from Poona in the west to Jorhat (Assam) in the east. In the location of the laboratories, many requirements had to be considered and met. The existence of industries which are directly benefited by the laboratory concerned, proximity to academic and research institutions, availability of buildings, transport and other facilities, these and many other factors had to be taken into account.

Tributes have been paid to the magnificence of the structures which have been put up in such record time. The buildings which house the national laboratories combine architectural excellence with utility.

The committees which were set up to prepare plans for the national laboratories have taken into account not only the immediate needs, but also the future requirements and prepared both short and long-term programmes of work for each laboratory. The work of the laboratories covers fundamental as well as applied aspects and pilot plant facilities have been provided for developing results of research and proving their industrial possibilities. Provision has been made for rendering technical assistance to industry, and symposia are organized from time to time to bring research workers into intimate contact with representatives

of trade and industry. The national laboratories also undertake scientific work relating to standards and specifications, and the National Physical Laboratory is the custodian of fundamental and derived standards.

In recent years, particularly since the last World War, organization of scientific research has undergone vast changes. Many problems require for their investigation the facilities provided by large-scale specialized organizations and expenditure of money, often running into millions, which could only be justified if diversified, co-ordinated and regulated application and professional continuity of work are guaranteed. Such work is not usually possible in universities where teaching and research go hand in hand and are essentially preparatory. Many problems of industry, and even of pure science, require for their solution the techniques of more than one branch of science and call for team work. A collection of experts in the various divisions of the national laboratories makes such team work possible.

The national laboratories undertake work which does not come ordinarily under the purview of industries or universities. One of their main functions is to bridge the gulf between research and its application to problems of human welfare. They undertake investigations on long-range problems of fundamental research which are not usually tackled in universities for want of funds or lack of facilities for organized research. Such problems are not ordinarily sponsored by industrial organizations as their solution does not hold out prospects of immediate monetary gain.

Very often the development work involved in the following up of a discovery requires great originality, and expenditure on such work is much higher than that involved in the discovery of the fundamental principle. Perhaps the most attractive and useful feature of the national laboratories is that they are equipped and organized to meet the needs of such development work.

The national laboratories, as pointed out by the Prime Minister on the occasion of the opening of the Central Building Research Institute, Roorkee, are basic institutions from which "waves of knowledge will emanate to improve India and better the living conditions of our people". He observed: "It is not easy to give a new face to so large a country which contains one-fifth of the world's population. Perhaps the only way of doing this difficult job is by creating among the people a temper of science so that it takes away the rut of sluggish habit and ushers in an era of blissful prosperity." In the creation of the scientific "temper" and in propagating knowledge revealed through objective inquiry, the national laboratories have indeed a great part to play. These laboratories have, for the first time, opened out opportunities for the talented youth of the country to undertake scientific research in diverse fields and by providing a link between the Government, science and technology, they have great contributions to make to the development of India's national industries.

THE NATIONAL PHYSICAL LABORATORY OF INDIA NEW DELHI

Introduction

THE foundation stone of the National Physical Laboratory was laid by the Prime Minister on 4 January 1947 and the laboratory was opened by the late Deputy Prime Minister, Sardar Vallabhbhai Patel, on 21 January 1950.

Scope & Functions

The functions of the National Physical Laboratory include: (1) Maintenance of research on fundamental and derived standards. (2) Research on industrial standards: (i) standards of quality; (ii) standards of performance; and (iii) standards of practice. (3) Investigations on raw materials for industries. (4) Standardization of raw materials, processes and finished goods. (5) Practical application of results of fundamental research. (6) Framing of, and advice on, specifications. (7) Scientific and industrial testing.

Divisions

The scientific work of the laboratory is carried out in the following nine divisions: (1) Weights and Measures; (2) Applied Mechanics; (3) Heat and Power; (4) Optics; (5) Electricity; (6) Electronics; (7) Acoustics; (8) Industrial Physics; and (9) Analytical Chemistry.

Personnel

The staff of the laboratory consists of a Director, a Deputy Director, 6 Assistant Directors, 12 Senior Scientific Officers, 16 Junior Scientific Officers, and an Administrative Officer besides others.

Research Programme

APPLIED RESEARCH

DIVISION OF WEIGHTS & MEASURES

Length Measurements — Large number of micrometers, depth gauges, height gauges and a Hilger profile projector obtained from army surplus stores have been reconditioned and serviced. A mercury isotope lamp has been received as a wavelength standard for metrological work.

Sieves are being standardized and certified for cement factories.

Mass Measurements — Test certificates based on an accuracy of two parts in a million for weights of ten grammes and larger and 0.00002 gramme for smaller weights are being issued for compliance to adjustments to class A and B tolerances, and for the values of mass on the weight in air basis.



NATIONAL PHYSICAL LABORATORY OF INDIA
NEW DELHI

Equi-arm analytical balances are being tested for performance.

Time Measurements—Three quartz clocks were designed and completed. Each multivibrator stage was carefully studied for performance. Arrangement has been made for alternative working from batteries in case of power failure.

Electronic equipment has been set up for carrying out experiments on frequency division by heat method. A thermostatic control unit is being designed for the testing of quartz crystals and frequency stability.

Molecular Resonance Clock—Work has been started on microwave circuits to set up a molecular resonance clock. To make the staff familiar with the special techniques involved the following equipment have been constructed: (a) A microwave secondary frequency standard to measure frequencies from 100 to 4,000 Mc. The accuracy achieved has been 5 parts in 10^5 ; (b) a standing-wave detector for the 3 cm. region; (c) a cavity resonator for the study of paramagnetic resonance in the 3 cm. region; (d) cavity resonators for 10 and 3 cm. work for measurements of dielectric constant, and loss angle of shellac and several other solids; (e) a klystron tube 2K33 (for 1.25 cm.) with tube mount and straight pieces of wave guides; and (f) a stabilized power supply unit giving an output of 2,000 volts has also been constructed.

Magnetrons—A new method of mode control of interdigital magnetrons is being investigated for obtaining controlled operation in more than one mode and for removing degeneracy of the first order mode by using a cavity of rectangular cross-section.

For work with "Cold Tests", an interdigital resonator in which the breadth of the cavity can be continuously varied was designed for operation with a "butterfly oscillator". It was found as expected that a length to breadth ratio of 3:1 would be required to separate the two first order modes by the same interval as the one between the lower first order mode and the zero order mode. Further separation between the two first order modes has been obtained by selective reduction in the radial thickness of the fingers in conjunction with the use of a rectangular cavity.

The original cavity has also been used to make a preliminary test. In an inverted interdigital magnetron, the anode being inside, the zero order mode can be coupled to a coaxial line tuned by a plunger without making the magnetic circuit awkward, as would be the case if the same sort of thing is attempted with the mode on the outside. It was found by cold tests that motion of the plunger gave a tuning range up to 1.8:1.

The following equipment have also been set up for fabrication and testing of operating magnetrons: (1) Equipment for brazing in hydrogen atmosphere; (2) vacuum system; (3) degassing furnace; (4) equipment for supplying voltage pulses to the cathode; (5) electromagnet; and (6) equipment for spraying the emulsion on the cathode.

Metal Detector—At the request of the Customs Department a metal detector consisting of a high frequency generator operating from a 800/cc. heterodyne type of receiver and a d.c. amplifier with a relay system was designed and constructed to help in the detection of smuggled gold, silver, platinum and other precious metals. The oscillator coil was electrostatically shielded so that when a metal object is introduced in the field of the coil, the electromagnetic field gets disturbed, the change being indicated as a change in frequency on a meter or by the flash of a red lamp or on a loudspeaker. After inspection by the customs authorities the equipment was installed at two ports.

Other Works — (1) Joshi effect is being studied to find out the time lag on the effect; (2) developmental work has been undertaken on inter-communication telephones to increase the number of useful lines without an operator; (3) type tests are being undertaken on hypodermic syringes; (4) apparatus for determining dry shrinkage and permeability was set up and tests were carried out on prefabricated slabs manufactured by the Government Housing Factory; and (5) standardization of audio frequency oscillators and testing of high frequency screened coals have been carried out.

DIVISION OF APPLIED MECHANICS

Plans for the workshop and organization of Central Stores and Transport Section were drawn up. Some practical work was undertaken for the Government Housing Factory, development of suitable designs for village *ghani*, bucket-elevators, cement-mortar sprayers, wind mills, automatic map racks, etc.

Testing of Materials — The following testing machines have been installed: (1) Universal Testing Machine (10 tons, 30 tons and 100 tons capacity); (2) 3,000 kg. Creep Testing Machine; (3) 120 ft. Izod Impact Testing Machine; (4) Fatigue Testing Machine; (5) Cement Briquette Testing Machine; (6) Vickers Hardness Machine; (7) Rockwell Hardness Testing Machine; (8) Hardometers; (9) Magnaflux Crack Detection Machine; and (10) Metallurgical Microscope.

Tests were undertaken for (1) Hardness (Vickers, Pyramic, Rockwell or Brinell); (2) Tensile Strength; (3) Double Shear; (4) Compressive Strength; (5) Izod Impact; (6) Creep; (7) Briquette; and (8) Cold Bend.

Photoelasticity — The following equipment were designed and fabricated: (1) A photoelastic bench which saved the laboratory to the extent of Rs. 25,000 and stresses in buffer hook and chain links were analysed; and (2) a Coker type compensator stress freezing oven with timing control for heating cycle for three dimensional analysis was designed and fabricated at the instance of Bhakra Dam Design Directorate and stress analysis of "Inspection Galleries" in Bhadra Gravity Dam is being carried out.

Vibration Analysis — (1) An attempt was made to arrive at a simpler method of calculating natural frequencies of vibration of rectangular plates under different boundary conditions in an electrodynamic type pickup; (2) experimental verification of theoretical analysis arrived at for trapezoidal plates; and (3) vibration analysis of the foundations of the compressors at Sindri Fertilizer Factory.

Stress Analysis by Electric Strain Gauges — For measuring static and cyclic stresses of very low frequency in machine parts and structures by means of electric resistance strain gauges a d.c. amplifier was designed and extensively used for measurement of unknown tensile and compressive stresses.

Elasticity — (1) Experimental work on the determination of torsional rigidity and shear stresses of non-circular sections using thin soap film surfaces led, without any complicated mathematical analysis, to accurate results, and (2) theoretical work on torsional rigidity of pre-twisted bars of narrow sections was also carried out.

Electro-metallurgy — Extensive experiments were successfully conducted on (1) copper, (2) nickel, (3) chromium and (4) silver plating to

give a decorative and protective finish to metal articles. Detailed research was also carried out on (1) anodizing and colouring of aluminium and its alloys; (2) chromium plating on aluminium; and (3) defects in the plating baths, their causes and remedies, especially in copper plating and oxidizing baths.

Engineering Metallurgy — (1) A new magnetic fluid for crack detection in machine parts, castings, forgings and weldings has been developed and covered by a patent. Civil aviation authorities have approved the fluid as suitable for testing aeroplane parts.

(2) A fluorescent fluid for surface crack detection under ultra-violet light has also been developed. Castings for gas retorts to withstand temperatures of 900°-1,000°C. for a number of heats have been produced. Experiments on ductile cast iron having tensile strength of 26 tons per sq. in. and Izod impact value of 45 ft./lb. shows great promise as a cutting tool to replace the costlier steel alloys.

(3) A number of silver solders having melting points between 400° and 700°C. have been produced. The determination of elastic constants of welded 24 ST Al. Alloy sheet has been taken up.

(4) An electric furnace for heat treatment has been made.

(5) A Wholer cantilever type machine for carrying out fatigue tests on a single rotating bar specimen under load has been designed and fabricated.

Wind Tunnel — A low speed atmospheric return wind tunnel consisting of a wooden framework, lined with plyboards with corners smoothed and fitted with micro-manometer recording a differential of 1/4,000 in. water has been designed. Variation of wind velocities at various points inside the test section has been successfully brought down to about 1 per cent of the mean. Velocities up to 30 miles/hr. have been obtained at the throat of the section. Tests have been carried out to estimate the aerodynamic efficiency of the tunnel.

Work done on behalf of the Nangal Research Laboratories — (1) An adiabatic temperature control unit for studying the temperature rise in mass concrete was designed and constructed. An adiabatic cabinet equipped with this apparatus studies the amount of heat generated per unit of concrete. The automatic controller designed is actuated by the signal from differential resistance thermometers, and regulates the temperature of the outer cabinet in consonance with the rise in the temperature of the mass concrete in the inner cabinet. The equipment was installed at Nangal site, and was worked satisfactorily. For the "mass curing cabinet" a similar apparatus was designed.

(2) An automatic sequence timing apparatus for the bleeding test of concrete was designed for the Concrete Laboratory, Bhakra Dam, to work a vibrating table automatically for every three seconds after every 30 seconds rest.

(3) Various sizes of panels, slabs and girders of different foam concrete and mixtures were tested for their compressive, tensile, flexural, vibration, buckling and bonding strengths and for accelerated weathering for the Government Housing Factory. A 100-ton column testing, frame and automatic arrangement for accelerated weathering test were designed and fabricated.

Extensive work on models of bucket elevators of three designs, cement and mortar sprayers and guniting equipment, and designs of village *ghani*, *charkha* and wind mills was conducted for the Board of Engineering Research. A detailed study was made of average wind velocities during

different times and different seasons in India, with particular reference to Delhi.

DIVISION OF HEAT & POWER

An oxygen plant from Army Disposals Stores was reconditioned for providing liquid air, each compressor being arranged for individual motor drive. The heat exchanger system was redesigned to obtain twenty litres liquid air per hour instead of liquid oxygen.

Solar Energy — For work on utilization of solar energy, various types of mirrors were designed and fabricated to produce solar cookers. The cookers are now being manufactured by two firms in Bombay and Calcutta.

A water heater has been fabricated and is under test. A hot air engine is under regular test for studying the efficiency of solar energy utilization. A larger engine has been designed and is being fabricated.

A large mirror system for generating enough heat for a 10 kW. steam engine is being designed. Work is also being done on using solar energy for running an "Electrolux" type of refrigerator.

Refrigeration — Two units received from disposals are being adapted for work on refrigeration. An analytical study for the selection of outside design temperature in air conditioning has been completed for homogeneous constructions. Tests were conducted on the use of water as a refrigerant.

Thermometry — Constant temperature baths are being fabricated for commercial testing of thermometers and pyrometers.

Engine Testing — A single cylinder Caterpillar engine for testing heavy duty lubricating oils has been installed.

The original engine set up for testing producer gas plants is used for occasional tests. Performance tests have been carried out on several makes of agricultural tractors in accordance with BSS 1744: 1951.

Among the instruments obtained from disposals and repaired are (1) a six-point recording pyrometer; (2) a direct reading temperature indicator; (3) two thermocouple type of potentiometers; and (4) a thermo stat and humidity recorder.

Arrangements to test the fuel consumption at different B.h.p. at the pulley of an agricultural tractor were completed. A tractor was tested by running it on kerosene oil for 200 hr. according to BSS 1744: 1951.

DIVISION OF OPTICS

Spectroscopic Work — 1. Isotope effect in MCO bands was investigated with a flame of deuterio-acetylene burning with atomic oxygen obtained at a pressure of 0.1-0.8 mm. Hg. An all-glass apparatus for production of atomic oxygen was set up following the design of Wood's discharge tube for atomic hydrogen.

2. A high frequency oscillator, having an output of 400 watts and a frequency range of 2-16 Mc., has been built to study the intensity variation in OH bands with pressure, power and frequency.

3. Absorption spectra of erbium and holmium sulphates (in solution) have been taken in the ultra violet region with a hydrogen discharge tube.

Luminescence — 1. Phosphorus activated by some rare earths was prepared to study the emission spectra of rare earths which do not fluoresce.

resce as pure compounds, and also the structure of base materials in which they are incorporated. In the latter case the rare earth impurities give a spectra of sharp lines, specially at low temperatures, and any variations in the spectra due to internal fields of the base material can be precisely studied due to the sharpness of the emission lines.

2. Zinc silicate phosphors activated by various metals like Cu, Mn, etc., were prepared.

Metallic Films—1. A metal evaporation unit for the deposition of metals on glass and other surfaces was built and used for coating half silvered and other mirrors for the interferometers. Samples of cloth were coated with metals for Shri Ram Institute for Industrial Research.

Details of an evaporation unit for coating sunglasses with thin films of metals were supplied to two industrial firms. In one case, sunglasses were actually coated and sent as specimens.

2. Thickness of thin films of metals is being measured by Multiple Beam Interferometry. A portion of metal deposited on the glass plate is removed and the plate is coated thickly with aluminium or silver. An optically flat plate is partially coated with silver or aluminium and is brought close to the first in a special mount. The pressure on two plates is adjusted by means of a beam of white light falling perpendicularly on them. A kink in the fringes which is visible corresponds to the depth of the original film.

Study of Crystals—1. Goniometric measurements were made on holmium and erbium sulphate crystals.

2. A new method has been developed for measurement of the principal refractive indices of crystals by fitting a two-circle goniometer with an extra attachment.

3. A thermostat chamber has been designed for crystallizing the different modifications of rare earth-paradibromobenzolsulphonates, which crystallize at different temperatures.

Chemical Work—1. A mixture of rare earths was extracted from the monazite sand.

2. An ion-exchange column for the separation of individual rare earth elements from mixtures by fractional crystallization has been set up. The solution of the mixture is adsorbed in a thin layer of the resin at the top of the column and eluted with citric acid solution of controlled pH when a separation of the elements takes place. The process has to be repeated several times with different fractions of the eluted solution to obtain elements in the pure state.

3. Some compounds of the rare earths were prepared for the study of their absorption spectra and for carrying out goniometric measurements of their crystals.

Apparatus Constructed—1. Twyman Interferometer for testing lenses, prisms and microscope objectives.

2. Resolution charts having 80, 160, 320, 480 and 560 lines per inch. By allowing different amounts of light to leak, charts of varying contrasts are being prepared.

3. A Mach-Jamin Interferometer with wide separation of plates for studies on anomalous dispersion of organic vapours. The dispersion of acetone vapour was measured by using mercury lines 5770, 5461 and 4358.

4. A photomultiplier unit for measurement of optical intensities.

5. Szivessy Compensator capable of measuring extremely small differences in optical phases.

6. X-ray spectrograph with curved crystals oscillating before the X-ray tube to obtain the lines of all elements from Ba to U simultaneously on one single photograph.

7. Preston circuit for the measurement of lumen output.

8. An apparatus for measurement of decay period of after-glow in atomic oxygen flames.

DIVISION OF ELECTRICITY

High Vacuum Work — To undertake fundamental research on high vacuum physics and to develop different types of instruments used in production and measurement of high vacuum, several glass mercury diffusion pumps have been designed, constructed, and used on various plants. Work on development of oil-metal pumps is progressing. Different types of vacuum gauges, for absolute and relative measurements have been designed and constructed with particular attention to stability and accuracy of calibration.

Nuclear Physics — Geiger counters and ionization chambers were constructed for the study of physics of nuclear radiations. Several types of the associated electronic circuits (stabilized power units for high tension and low tension supplies, amplifiers, scalars, coincidence units and recorders) have also been developed and constructed.

These counters will be utilized for the study of absorption coefficient of nuclear radiations and elucidation of energy spectra by absorption methods.

As part of the study of nuclear radiation physics, re-investigation work has been carried out on the development of Beta-ray spectrometer and the construction of a solenoidal type of spectrometer for the investigation of low energy spectra has been completed. A larger spectrometer is being designed.

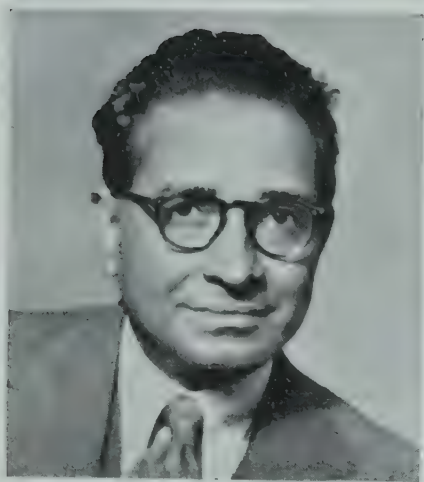
X-rays — Philips X-ray diffraction unit, which takes a sealed-in type X-ray tube, has been used for the study of order-disorder phenomenon in Cu-Zn and Ag-Zn systems. Structure identification tests of titanium dioxide, pearls, mercury and p-dichlorobromobenzene have been carried out.

A high tension power unit for a demountable X-ray tube for spectroscopic work has been assembled. An X-ray spectrograph using a curved crystal grating has been designed and constructed. With this equipment it is proposed to study "fine structure" and X-ray spectroscopy of rare earths.

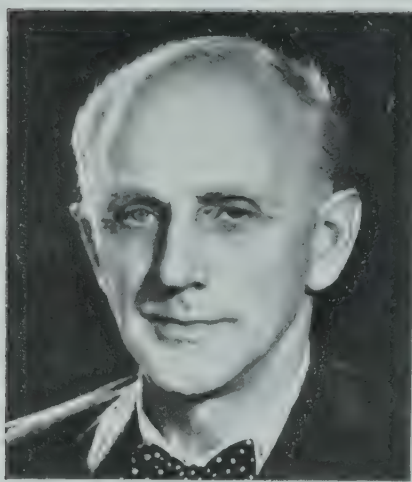
Electrical Standards — A number of standard electrical instruments have been permanently set up to facilitate routine electrical tests. Calibration of various electrical measuring instruments has also been carried out. A Carey-Foster bridge was designed and constructed to compare two resistances for an accuracy of one part in a million. Several other bridges have also been designed. Arrangements for making standard cells as a source of standard potential for use in precision work have been made.

DIVISION OF ELECTRONICS

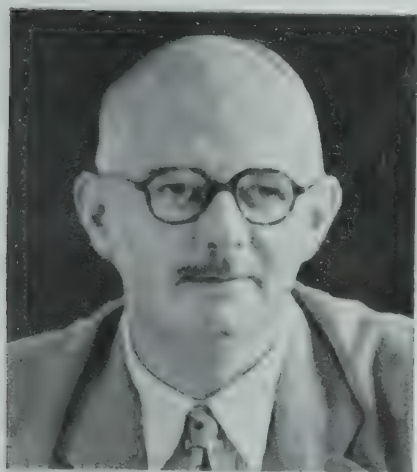
Dielectric Measurements in the Microwave Region — The problem on hand is the measurement of the dielectric constant, and the power loss of certain organic solids and liquids in the 3 and 10 cm. bands, employing



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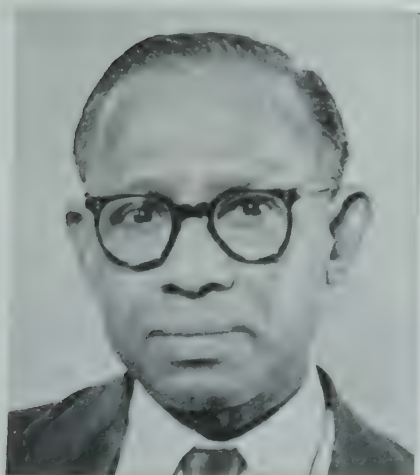
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a short-circuited-transmission-line method which can be used for both high and low loss media.

The following units of the 3 cm. band equipment have been designed and constructed.

Microwave Plumbing Units — 1. A standing-wave detector, and its probe-assembly. The relative displacements of the probe can be read to an accuracy of ± 0.01 in., its total possible movement being about 4.5 in. long.

2. An uncalibrated non-reflecting type flap-attenuator, utilizing an IRC resistive strip as the dissipating element, the attenuation being from about 10 db. to about 20 db.

3. A crystal-detector unit, incorporating special features like a choke plunger, impedance-matching slugs, etc., besides the usual crystal-holder assembly.

4. Klystron mount.

Electronic Units — 1. Cane compact unit consisting of two electronically regulated power supplies for the Klystron Oscillator-tube and an a-f (1,700 c.p.s.) square-wave modulator to pulse-modulate the reflector-voltage of the Klystron.

2. A high-gain (about 100 db.) linear feedback amplifier, with frequency response constant within 3 db. from about 100 c.p.s. to about 15,000 c.p.s.

3. An apparatus for maintaining the sample-cells at constant temperature.

Determination of Nuclear Gyromagnetic Ratios — The method selected for the determination of the gyromagnetic ratios of the various atomic nuclei is the Nuclear Magnetic Resonance Method, using the "Nuclear Induction" technique.

The following units of the required equipment have been designed and constructed.

1. The radio-frequency head (sample holder), consisting of a finely finished rectangular chamber of silver-plated brass, housing the two plastic formers for the transmitter and the receiver coils, with their axes accurately aligned to be at right angles to one another. There is a special arrangement to vary the electromagnetic coupling (in particular, to reduce it to a minimum) between the two coils.

2. A high-gain a-f voltage amplifier, whose gain (about 65 db.) remains constant within 3 db. from about 5 c.p.s. to about 5,000 c.p.s.

3. A highly stabilized electronically regulated power supply giving 150 amp. maximum current output at 300 volts d.c. Its ripple-output is less than 2.0 millivolts r.m.s., its output impedance is less than 1.0 ohm for slow variations in load, and its stabilization factor is more than 1,000.

4. A stabilized R-C power oscillator, yielding 60 c.p.s. frequency to modulate the constant high magnetic field, and having special arrangements for frequency and amplitude stability.

5. A high-gain tuned feedback a-f amplifier (with variable resonance frequency) for use with a recording milliammeter.

6. Appropriate R-f amplifiers for the transmitter and the receiver.

DIVISION OF ACOUSTICS

Thermosonics — Thermosonics, a new branch of acoustics dealing with the relationship between sound and heat, is based entirely on the work

initiated and pursued in this laboratory on the thermal effect of ultrasonics which led to an equivalence relationship between sonic and thermal energies.

1. *Equivalence of Sonic and Thermal Energies*—Arising out of researches on the heating properties of ultrasonic waves when they pass through liquid media, the remarkable observation of sonic equivalence of thermal energy was reported. Measurements in a large number of organic liquids show that the ratio of sound (I) to heat energy (H) is constant for all liquids and has a value of 4.19×10^7 erg cal. (J) which is in remarkable agreement with similar constants of proportionality (Joule's equivalent) determined by the conversion of mechanical or electrical energy into heat. This new relation is expressed by the equation $I : JH$.

2. *Absorption Coefficient from the Relation $I : JH$* —Values of heat measurements at any two points on the axis of the sound beam, separated by a known distance, are governed by an equation involving the absorption coefficient of the medium. The relationship provides a new method for the measurement of ultrasonic absorption which has been used for sound absorption measurements.

3. *Absorption Coefficient from Heat*—At low frequencies (420 kc. s.), heat output bears a constant ratio to the experimental value of the absorption coefficient in all liquids and at higher frequencies the relationship holds good in most of the liquids. At 15 Mc. s., however, no such relationship was noticeable.

Absorption of Ultrasonics in Liquids—1. Absorption coefficient of high frequency sound waves in liquids is far in excess of the value calculated on the theory of Stokes and Kirchoff according to measurements in various laboratories and there had been a divergence in the results obtained by workers using different methods. Measurements have been made in a large number of liquids by several methods including two original methods developed.

(a) *Thermal Method*—Absorption coefficients were measured in 21 liquids by this method and also by radiation pressure method. The values showed good agreement. At 420 kc./s., the heat output is proportional not to the experimentally determined values of absorption coefficient at higher frequencies, but to its classical values, indicating the possibility of low frequency absorption of ultrasonics being in accordance with theory. A number of liquids were subjected to further examination in the frequency range 30-15 Mc. s. The results show that for some of the liquids examined, the heat output is proportional to observed values up to 5 Mc. s. Above this frequency, however, the proportionality does not hold good for any liquid.

(b) *Alternative Thermal Method*—Heat output at a point on the axis of the sound beam is a function of the sound intensity at that point. By using this technique to determine the absorption coefficient in liquids, the results obtained for a number of liquids show good agreement with values obtained by radiation pressure method.

(c) *Optical Method*—In measuring the absorption coefficient of liquids, and to overcome the usual errors encountered, two independent light beams of equal intensity were used simultaneously to cross the same sound beam at two different levels and the two diffraction spectra so produced were recorded simultaneously on the same photographic plate. The intensity of sound fields at two known points is then calculated from the relative intensities of the diffraction lines in the various orders measured.

on a microphotometer. The results show good agreement with previous values and no deviation is observed due to this new approach.

(d) *The Radiation Pressure Method* has been used with some modification to study the absorption coefficient of 47 liquids at a frequency of 5 Mc./s. and of 24 liquids at 15 Mc./s. Liquids were classified into various groups according to their molecular structure based on the ratio of the observed value of absorption to that calculated theoretically.

Variation of Absorption Coefficient with Frequency — Study of the variation of absorption coefficient with frequency in a number of organic liquids by the radiation pressure method at 5, 10 and 15 Mc./s. showed that for non-associated polyatomic liquids like toluene, m-xylene, etc., the coefficient remains approximately constant with change of frequency. In the case of esters the value of absorption coefficient drops to one-third when the frequency is increased from 5 to 15 Mc./s.

Dependence of Sound Intensity on Absorption — The radiation pressure method was used to measure the sound intensity at a number of points in different liquids and the intensity at the radiating face was estimated in each case by extrapolation. These measurements were taken both at 5 and 15 Mc./s. in a number of liquids. The results indicate the dependence of the sound output on the absorption coefficient of the medium.

Dispersion of Sound Velocity — A new and unique method has been developed whereby diffraction patterns produced by two sound beams of different frequencies are simultaneously photographed on a plate. The ratio of fringe width corresponds to the ratio of frequencies and deviation indicates dispersion. Within the limits of experimental accuracy, there is no evidence of dispersion in this range. Velocities have also been measured at low ultrasonic frequencies in various liquids by Schlieren method.

Viscosity & Anomalous Absorption — One of the explanations for the excess absorption of ultrasonic waves in liquids is the presence of a second viscosity in the medium in addition to the normal shear viscosity. The value of this coefficient has been found by some workers on theoretical grounds and indirect experimental measurements. A new approach to this problem was made by determining the Q of the vibrating quartz crystal by measuring the rate of decay of oscillation in different media. Investigations were carried out on a large number of media covering a wide range of viscosities from air to castor oil. Q is found to be a function of shear viscosity over the entire range. It is seen that in this phenomenon the oscillations of the quartz crystal vibrating at ultrasonic frequencies are damped by the shear viscosity of the medium and not by the second viscosity.

This was confirmed by measuring the decrement of the piezoelectric current of a vibrating quartz crystal after removing the exciting voltage. The decrement always followed the change in shear viscosity which decreases with rise in temperature but ultrasonic absorption in some of the liquids increases with rising temperature.

Dependence of Sound Intensity on Frequency — Further investigations on the relation between the amplitude of the radiator and the sound energy radiated showed that if the crystal is made to oscillate at different harmonics, the exciting voltage being kept the same, the current increases at higher frequencies.

Simultaneous measurements of heat output indicate that there is a gradual drop in the sound energy at higher harmonics. This problem is being

pursued to find out the relation between the amplitude of the radiator and sound output at different frequencies by other methods.

Oscillations at Even & Half of Odd Harmonics — A piezoelectric quartz crystal usually oscillates either at the fundamental frequency or any of its odd multiples. However, for detailed investigation of the problem a number of crystals obtained from different sources were carefully plated and excited by oscillators with buffer stage in between the oscillator and the crystal. The intensity of the ultrasonic output was determined by photographing the diffraction pattern and measuring the density of the diffraction lines. The results show that, under certain conditions, the crystal can be made to oscillate at any frequency, but it has preferred modes of oscillation at even and half of odd multiples of its resonant frequency in addition to the odd harmonics.

Oscillations of a Quartz Crystal Simultaneously at Two Frequencies — In the course of studies on dispersion, it was observed that when the quartz crystal was excited at two frequencies simultaneously, the first order diffraction lines of the high frequency are bracketed by lines corresponding to the sum and difference of the two frequencies. However, the relative intensities of these side lines were seen to be always unequal. Extending Brillouin's theory to this case, this observation has been explained on theoretical grounds.

On the basis of this extended theory, it has also been possible to make certain predictions regarding the variation in the intensity of these lines with change in relative frequency, etc. Subsequent experimental investigations support these arguments.

Amplitude Modulated Oscillations of a Quartz Crystal — A special case of complex diffraction pattern was observed in which the first order lines were bracketed by side lines corresponding to the sum and difference of the two frequencies, but the side lines surrounding the zero order were absent. This pattern is attributed to the excitation of the crystal by an amplitude modulated carrier wave and the observation has also been mathematically explained.

The elementary theory of Raman and Nath as well as Brillouin's theory have been used to explain the diffraction pattern due to agitation of the liquid by an amplitude modulated beam and intensity expressions have been derived for the diffraction lines. It is found that the theory of Brillouin is more suitable when fewer and weaker diffraction lines appear on the pattern.

Theory of Diffraction of Light Ultrasonic Waves — The generalized theory of Raman gives non-converging expressions for the intensities of the various orders whereas other theories due to Brillouin, Rytov and Erwin David provide closed expressions for the first and second order lines only. To overcome any ambiguity, the latter theories have been derived from the single generalized theory of Raman and Nath and the conditions under which they are applicable have been studied theoretically. Further, the first three terms in the generalized intensity expressions of Raman and Nath have been calculated for all the diffraction lines with the help of these terms.

Some general conclusions regarding the intensity of the diffraction lines at oblique incidences have been drawn and found to be in accordance with experimental results obtained earlier.

Ultrasonic Waves & Chemical Constitution — Sound velocity values have been recently redetermined in 48 liquids from different groups to check the previous values and the validity of the rules suggested earlier.

The velocity values have been found to be correct and the general rules regarding aliphatic and aromatic compounds and compounds having different viscosities and different types of isomers are found to hold good. The particular rules regarding lengthening of the chain, introduction of heavier atoms, lengthening of double bond and electric moment are also found to hold good.

Studies on sound velocity in organic compounds in relation to their viscosities have given some interesting results.

DIVISION OF INDUSTRIAL PHYSICS

Work on developing various carbon products from indigenous materials and with equipment made locally was started a few years back. Brushes are now being produced on pilot plant scale, and supplied to Government departments and industrial concerns to gain manufacturing experience and also to obtain reports from users. The process is being leased out for commercial exploitation. Efforts are now being made to produce arc carbons, big electrodes, carbon-oil seal rings and other carbon articles.

A number of problems of fundamental importance to various industries are being studied. Some of these problems are (1) particle size studies in the sub-sieve range by sedimentation, turbidimeter and air permeability methods and (2) packing of powders to get maximum density.

Beneficiation of Indian Graphite — Indian graphite ores have a high percentage of ash. Work was undertaken to treat and use the ores for the manufacture of carbon-graphite brushes, black lead pencils, dry cells, graphite paints and lubricants. Efforts are now being made to put the work on a pilot plant scale. Necessary equipment is being manufactured.

Experience has been gained in graphitizing carbon articles in electric furnaces.

Activated Manganese Dioxide for Dry Cell Manufacture — Imported activated manganese dioxide is admixed with indigenous ores to a certain extent. Activated manganese dioxide has been made from indigenous ores in the laboratory and efforts are being made to put it on a pilot plant scale.

Help to Pencil Industry — The question of giving technical help to the pencil industry was referred to the laboratory by the Tariff Board in 1951. Help was given to a firm for improving their technique for firing of black leads.

The Controller of Printing & Stationery had referred the question of standardization of pencils to the laboratory. A non-destructive method based on measurement of electrical resistance of pencils was developed to judge the uniformity of production. A new method has been developed to judge their writing quality. Apparatus for testing these and other properties has been designed and built. Draft specifications will soon be drawn up.

Hydrated Lime — Hydrated lime manufactured by a certain firm was tested for particle sizes and was found to fall in two groups, the coarser one containing most of the impurities. If the material of 30 mesh is removed, the quality of the lime improves. Two tons of hydrated lime was treated in a cyclone separator.

Standardization of Cements — At the suggestion of the Indian Standards Institution, an apparatus has been designed and is being built to

standardize the fineness of cement and to prepare standard cement samples. Preliminary experimental work has been undertaken.

Bone Digester — At the request of Food & Agriculture Ministry, help was given in designing and manufacturing a bone digester on the Japanese model for use by villagers, which is now being made by a firm in Bombay. A bone crusher, manually operated, has also been made in the laboratory. Work on the development of a suitable evaporator for glue water is in hand.

A list of equipment built in the Division is given below.

Carbon Products Manufacture

1. A 20-ton hydraulic extrusion press, machine operated
2. A 200-ton hydraulic press, manually operated, for extrusion of big size electrodes (both the presses are designed for steam heating)
3. Two-roll steam-heated water-cooled mixer for mixing plastic materials
4. Cyclone separators
5. Ball mill
6. Conical mixer
7. Sieve shaker
8. Special electric furnaces for baking of carbon articles
9. Extrusion dies for extruding solid, i.e. round and square rods and cored rods
10. Dies for various sizes for pressing carbon articles
11. A new type of magnetic separator*
12. Special testing equipment for carbon brushes
13. Special equipment for fixing leads to the carbon brushes
14. Control gadgets for controlling various processes of manufacture

Equipment for Beneficiation of Indigenous Graphite

1. Laboratory size flotation cell
2. Flotation cell for handling large quantities has been designed and is under construction
3. Rotary kiln
4. Large capacity suction filter

DIVISION OF ANALYTICAL CHEMISTRY

A study has been made of the complexing of metal ions with organic acids, and analytical methods based on the complexing characteristics of the ions have been developed. Methods have been developed for the estimation of arsenic or antimony in the presence of copper. The same method has been extended to the system Fe-V and Cu-V.

A method has been developed for the estimation of boric acid in a nickel-plating bath without separating nickel or complexing with expensive or poisonous complexing reagents. This method has been tried at several levels of concentration of boric acid, and is found to work satis-

* Patented. The magnetic separator is of a new type specially designed to separate out very fine iron particles (- 100 mesh) which are intimately mixed with ground material during grinding.

factorily. The method is being extended to the bath solutions containing fluoride and ammonium ions.

Work on paper chromatography is being continued and details regarding separation of fractions of polymerized fatty acids have been worked out.

Preliminary experiments on the detection of phenols in bitumen show that phenols can be eluted on a square filter paper sheet by alkali. The phenols are converted *in situ* into a diazo compound that resolved with methyl ethyl ketone in a direction at right angles to the former.

A method has been developed for the estimation of mandelic acid by oxidation with ceric sulphate. Several typical pharmaceutical preparations which contain mandelic acid have been analysed and it has been shown that the results obtained compare favourably with more laborious methods.

The method is being extended to the volumetric determination of zirconium.

A modified form of periodic classification has been published with the elements arranged in a spiral form with group II having a central position. This arrangement leads to a better classification in terms of the filling up of various sub-shells.

A special container was devised for the W.H.O. and U.N.I.C.E.F. teams operating in India for the transport of B.C.G. vaccine.

Diphenyl hexatriene and diphenyl octatetraene have been synthesized with a view to studying their crystal structure.

A highly purified sample of p-chloro bromobenzene was prepared in order to study its crystal structure and dipole moment.

The structure assigned to products obtained by the condensation of phenyl benziminobenzene and ethyl-5-di-acetoacetate and subsequent crystallization by previous workers have been found incorrect. New satisfactory structures have been proposed and recently confirmed by synthetic and other degradative studies. This work revealed several new interesting rearrangements.

Work on the lactonization of S-benzal-benzoyl propionic acid is being continued. The lactone thus obtained has a dipolar structure not yet encountered. Work on the identification of the product obtained is in progress.

FUNDAMENTAL RESEARCH

The following major investigations have been carried out.

1. A new method has been developed for determining the thermionic constants of metals and alloys. The method is based on the determination of the saturation vapour pressure of the electron gas in thermal equilibrium with the substance at different known temperatures. The vapour pressure is measured by determining the rate of effusion of the electron gas from a chamber scooped out of the substance through a small hole in a thin wall of the chamber. In the actual practice, the chamber was constructed from a thin-walled tube of Acheson graphite, which can be heated in vacuum to high temperatures by sending a suitable electric current through it. The inside walls of the chamber can be coated with the metal or the alloy whose thermionic constants are to be studied. This method could, therefore, be applied for measuring the constants of many metals that cannot be studied by the usual diode method. Not only can the work function be determined accurately by this method but

also the A-coefficient, which means that the small temperature coefficient of the work function also can be determined accurately by this method.

This method is completely insensitive to the effect of the adsorbed gases on the surface, since the adsorbed layer does not affect the saturation vapour pressure, though it will affect the rate at which equilibrium is restored when disturbed. The effusion through the hole bears a close analogy to the electromagnetic radiations from a cavity, which are independent of the nature of the walls of the cavity. In a series of the papers published in the *Proceedings of the Royal Society*, the thermionic constants of graphite and of all the metals of the first transition group of elements from titanium to nickel, and of the monovalent metals copper, silver and gold, have been determined by this method. The results are discussed in relation to the electronic structure of these metals.

The method is now being extended to alloys and semi-conductors.

2. In the course of the above investigations it became a problem of some importance to determine the detailed distribution of temperature along a thin-walled tube or a thin rod or filament electrically heated *in vacuo*. The differential equation determining the temperature distribution in a thin rod or filament can be readily formulated, and also its integral solution. The integral, however, cannot be evaluated directly, and hence all the early work on temperature distribution in heated filaments had been confined either to the evaluation of the integral under special conditions, or in the general case to numerical or graphic computation. It is now found that the integral can be evaluated in the form of a power series which is found to be rapidly convergent in most parts of filaments. The rod divides itself naturally into two distinct regions, in which the series used for evaluation are different, and the main features of the temperature distribution in the two regions are also different.

A detailed investigation of the temperature distribution has been given in the first part of a paper published recently in the *Proceedings of the Royal Society*. The second part, relating to detailed experimental studies on the temperature distribution in relation to the main results deduced theoretically in Part I, will be published shortly.

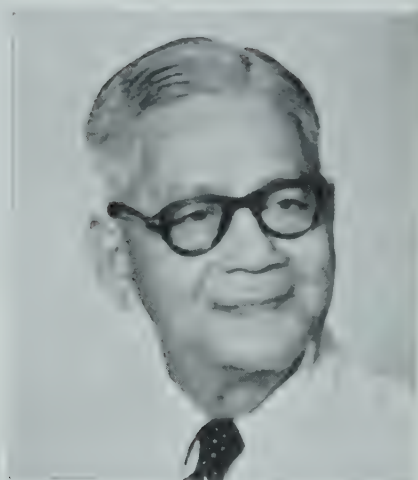
3. The frequencies and the anharmonicities of the normal modes of oscillation of the alkali halide crystals have been studied in detail on the basis of the simple Born model, in which the different ions in the crystal are regarded as being kept in their equilibrium positions by the electrostatic interactions between the charges and the repulsion interactions between the neighbouring ions. A detailed study of the two special cases, namely the principal lattice oscillations, and the oscillations of low frequencies, have been completed, and form the subject-matter of two papers published in the *Proceedings of the Royal Society*. A very significant result that emerges from these investigations is the important part played by the polarization field associated with the nuclear displacements of the ions, which is found to have precisely the Lorentz value, whereas the polarization fields associated with the electronic displacements are found to be practically zero. Some of the implications of these results and in particular the effect of the anharmonicities on the specific heats at high temperatures are discussed in the papers referred to.

The other normal modes are being studied and the results will be published shortly.

4. Closely associated with the effect of the polarization field on the frequencies is the important part played by the polarization field in refraction phenomena. It is found that the effect of the polarization field



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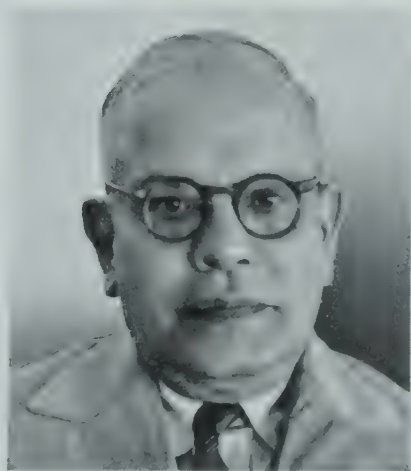
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on the refraction can be taken into account in two *alternative* ways, which are equivalent. It may be regarded as increasing suitably the effective field that produces the polarization, i.e. the effective field will now consist of not only the field in the medium but also the polarization field. The result will be an enhanced refractivity. *Alternatively* the polarization field may be regarded as changing the frequencies of the oscillators. In other words, the frequency of the assemblage of oscillators will be very different from the frequencies of the individual oscillators and the difference is due to the polarization field. These two alternative effects of the polarization field lead to the Lorentz and the Drude formulae respectively for the dispersion of the refractive index with frequency, and gives an insight into the relationship between the two formulae.

These and other aspects of the polarization field on refraction are discussed in detail in some papers published in the *Philosophical Magazine* (London).

5. A new method has been developed for the determination of the principal refractive indices of transport single crystals. The crystal is mounted on the head of a two-circle goniometer, and is surrounded by a suitable liquid bath. The prisms formed by the natural faces of the crystal refract the incident light from the collimator in different directions, and by suitably orienting the crystal these various refracted spots, as viewed through a telescope, may be made to *coalesce*. When this happens, the refractive index of the crystal for one of the principal directions of vibration, corresponding to the given direction of propagation, should be the same as the refractive index of the liquid. The method is very sensitive, and the crystal orientation corresponding to the coalescence of all the refraction spots may be determined with great accuracy.

The refractive index of the liquid is determined with the help of a crystal of calcite which is mounted along with the crystal to be studied and, therefore, refers to exactly the same conditions of temperature under which the crystal measurements are made.

The method, besides being very elegant, is also precise. Several single crystals have been studied by this method.

6. The scattering of light by a homogeneous medium may be regarded as the reflection of the incident beam of light by the appropriate thermal elastic waves in the medium and many of the interesting features of light scattering come out elegantly on this basis, particularly the intensity and the polarization of the scattered light, and the change in wavelength. This point of view is helpful in investigating the scattering of X-rays in forward directions, which closely simulates light scattering (*Proceedings of the Royal Society*, 1948).

7. In the course of these investigations some interesting results concerning quadrature have been obtained. The area included between any given curve $y=f(x)$ and the x -axis is naturally obtained by integrating the function with respect to x . It is found that there are several functions for which the integral can be obtained by adding the ordinates at equal intervals α , and multiplying the sum by the magnitude of the interval provided the interval does not exceed a certain limit depending on the nature of the function. The division into intervals may start at any point, i.e. the origin, namely $x=0$, need not be one of these points. The property may be stated mathematically in the following form

$$\alpha \sum_{n=-\infty}^{+\infty} f(n\alpha + \theta) = \alpha \sum_{n=-\infty}^{+\infty} f(n\alpha) = \int_{-\infty}^{+\infty} f(x) dx$$

$0 < \alpha \leq \alpha_0$, where α_0 is determined by the nature of the function and n is an integer. $f(x) \sin \alpha x$ is a typical example, in which α may be as large as 2π . In a paper published in the *Proceedings of the Indian Mathematical Society*, attention is drawn to this property and a criterion is given for formulating such functions. The criterion is that the Fourier transforms of these functions vanish beyond a certain finite range.

Several interesting identities given by Ramanujam can be deduced from the equivalence of the integral and the corresponding infinite series.

8. The electrical resistivity of monovalent metals can be attributed to the scattering of the electron waves taking part in the metal and the consequent attenuation of these waves in their passage through the medium. The wavelength of the electrons participating in the conduction is known, since it corresponds to the Fermi surface, which in these metals is practically a sphere. Now the intensity of scattering along any given direction will depend on (a) the atom form factor, or the cross-section of the atom for scattering and (b) the structure factor of the medium. The latter quantity will be the same as in X-ray scattering and is known in detail. The atom form factor can be obtained roughly from the known scattering of slow electrons in the rare gases. One thus obtains naturally an explanation of many of the observed features of electrical conduction by monovalent metals. The Fermi wavelength, which is only slightly above double the interatomic distance, is found to be long enough for the Einstein-Smoluchowski formula for density scattering to be applicable.

9. The same ideas can also be applied to explain the electrical resistance of liquid metals, and in particular the marked difference in behaviour, even in the liquid state, between the monovalent metals on the one side, and the polyvalent metals on the other. The electronic wavelength is long enough in the former metals to make even the backward scattering fall well within the first diffraction maximum, whereas in the polyvalent metals it is well outside and hence the scattering is enormously greater, and hence also the resistivity.

The increase of resistance of melting is also explained very satisfactorily on this basis, since the diffraction maximum is broadened by the melting, and the scattering inside is correspondingly enhanced.

10. The resistivities of binary alloys also can be investigated in detail in terms of the scattering of the electrons. In addition to the scattering due to the thermal fluctuations in density, there is a very large scattering because of the fluctuations in concentration, and the latter accounts for the enormously increased electrical resistivity of the alloys as compared with those of the constituent metals.

The calculation of this extra resistivity due to the concentration scattering can be done readily, since one merely needs to formulate an expression for the free energy in terms of the concentration, and obtain the second differential coefficient with reference to the concentration. Some of the well known order-disorder alloys have been studied by this method. Extensive experimental studies have also been made and the data are discussed in relation to the results deduced theoretically.

PROJECT ON RADIO COMPONENTS

At the suggestion of the Radio Research Committee the laboratory was asked to undertake developmental work up to pilot plant stage.

the production of vital components of the radio industry such as (1) silvered mica capacitors; (2) high dielectric constant ceramics; (3) high frequency ceramics; (4) cracked carbon film resistors; (5) volume controls; and (6) electrolytic condensers.

During the past three years considerable progress has been made on the production of the first two of the above components.

Silvered Mica Capacitors — A process has been developed for the manufacture of silvered mica capacitors on a pilot plant scale. The process has two novel features: (a) a chemical of the plasticizer type has been developed which can control and give a high degree of adherence of the silver film to the mica surface, thus ensuring a high stability for the capacity of the condenser; (b) the silver coating procedure makes production possible on a continuous schedule which is also economical; tests show that the condensers made have all the desirable electrical and mechanical properties. Samples of various values required for radio receivers and special hermetically sealed high value condensers for the telephone industry have been made.

High Dielectric Constant Ceramics — The dielectrics generally used in the manufacture of condensers are paper, waxes, mica, etc., and these have dielectric constants varying from 2 to 10. Titanium dioxide has a dielectric constant of about 100, and titanates of barium and strontium have K values going up to a few thousands, and some of them have other desirable electrical properties such as low power loss and good electrical strength. Therefore, it is possible to make small size capacitors out of these having sufficiently large capacity for use in radio receivers and other electronic instruments. In India, the Travancore beach sands abound in rutile which is almost pure titanium dioxide. A process has been worked out for utilizing the beach sands directly into finished condenser bodies.

A pilot plant has been set up for manufacturing ceramic dielectrics from titanium dioxide with K 100 and from barium titanates with K 2,000. Thin plates to a minimum thickness of about fifteen mills (0.015 in.) and about $\frac{1}{2}$ in. diameter have been made on a commercial scale using the Stockes ceramic tabletting press. This has made possible the manufacture of condensers with values from 100 to 1,000 $\mu\mu\text{f}$ with barium titanates. The values given above are for single plates and are increased to ten times the above figure when "stacking" procedure, which has also been developed, is adopted. It is possible that ceramics may gradually replace the usual paper condensers, as India does not manufacture the requisite quality of kraft paper or aluminium foil or the waxes needed for making paper condensers.

One of the main equipment used in the manufacture of ceramic condensers is the sintering furnace giving temperatures over 1,400°C. The laboratory has constructed three types of furnaces which employ (1) gas, (2) crude oil, and (3) electricity. All these furnaces have been successfully worked.

The development of high dielectric ceramic materials is closely connected with the miniaturization of components necessary for "printed circuit techniques". The silvering process for coating ceramics with conducting leads has been fully worked out. It may be mentioned that in both the types of condensers developed, namely mica and ceramic, all the main materials used are indigenous. The Radio Components Section of the laboratory has been responsible for working out "tropicalization" methods of radio components. The conditions of high ambient temperatures coupled with

high humidity obtaining in the country necessitate special type of protecting treatment for most of the radio components. The value of proper tropicalization methods is being greatly emphasized on the manufacturers in India by the methods worked out in this laboratory.

In view of its very specialized nature, the testing work on radio components is being carried out by the special radio components unit.

Testing facilities provided are being regularly used by the radio industry and, under an arrangement with the Development Directorate of the Ministry of Commerce & Industry, the All India Radio and the NPL, test certificates are taken into account before export permits are given. All the various components used in sets submitted to the laboratory are tested for tropicalization and the entire sets are tested for performance.

The section is equipped with the following instruments for carrying out tests on radio receivers and radio components: (1) G.R. Standard Signal Generator, type 805 C; (2) G.R. Distortion and Noise Meter, type 1932; (3) G.R. Load Distortion Oscillator, type 1300; (4) G.R. Amplitude Modulation Monitor, type 1931-A; (5) G.R. Output Meter, type 583-AH; (6) Dumont Oscilloscope, type 303-AH; (7) Ballentine V.T.V.M. with Decade Amplifier, type 300; (8) G.R. d.c. Amplifier, type 715-A; (9) Marcon Q-meter; and (10) G.R. Capacitance Bridge, type 716-C.

Besides the above, the following instruments have been built in the laboratory: (1) Noise Meter for testing volume controls; (2) Audio oscillator; and (3) Stabilized Power Supplies. The following are nearing completion: (1) 175 watt Audio Amplifier; and (2) a General Purpose Oscilloscope using 5 BPI cathode ray tube received from army surplus.

The Government of India has set up a Committee on Deaf Aids, and the laboratory was requested to undertake the investigation on the possibility of providing cheap personal and group hearing aids. A number of firms abroad have been contacted with a view to collecting data on the availability of various components. A few samples have been received and orders are being placed for a stock of components to enable new designs to be tried out. The deaf aids sets, as available currently are very expensive and as such beyond the means of a large number of people who need such help. It is proposed to try out circuits with cheaper components. Attention is also being given to manufacturing such sets from printed ceramic circuits.

LOW TEMPERATURE SECTION

Early in 1951, the laboratory initiated plans to set up a new section for low temperature physics and asked Unesco to support this project. The services of Dr. David Shoenberg of the Royal Society Mond Laboratory, Cambridge, an expert in this field, have been utilized for this purpose. On his advice the two major items of the equipment, a Collins helium cryostat and a large electromagnet, were ordered from the United States late in 1951. These were paid for under the Point Four Programme of Technical Assistance. Dr. K. G. Ramanathan, who had completed a research course and spent six further months on a Unesco Fellowship in Cambridge discussing preliminary plans with Dr. Shoenberg, also joined early in 1952. Dr. Shoenberg visited New Delhi during the months of August and September 1952, under the auspices of Unesco, and together with Dr. Ramanathan organized the preliminary work of the new section. Orders were ab

placed through Unesco for many items of auxiliary equipment not otherwise readily available (a motor generator set for the electromagnet, pumps and vacuum equipment, special glass tubing, electrical instruments and many smaller items). The Collins cryostat and the electromagnet arrived in September 1951 and were installed by two American engineers, and helium was liquefied for the first time in India.

The projects under investigation are: (a) study of the magnetic properties of metal single crystals at very low temperatures; the large electromagnet should make possible some interesting extensions of Dr. Shoenberg's earlier work made at more modest magnetic fields; (b) determination of specific heats of various metals and study of certain aspects of lattice dynamics and electron theory of metals; and (c) study of thermal expansion at very low temperatures; the aim is partly to verify certain predictions of lattice dynamics, and also to study the discontinuity of thermal expansion expected at the superconducting transition point.

The liquefying equipment and the electromagnet have been run successfully several times. Some work is also being done on the development of a cryostat for studying magnetic anisotropy at temperatures between liquid air and room temperature. It should be noted that the problems being studied at present are of a purely academic rather than of practical interest, but it is to be hoped that they will provide valuable scientific training in a branch of science not hitherto studied in India.

One of the research assistants from the section is at present with the C.S.I.R.O. in Sydney under the Colombo Plan, and another at the Cryogenic Laboratory in Leiden with a Fellowship from the Dutch Government, both doing research work in low temperature physics.

GLASS BLOWING SECTION

The National Physical Laboratory has under active consideration a scheme for the development of glass technology with special reference to undertake on a pilot plant scale the following work.

1. Repairing and reconditioning of radio transmitting valves and rectifiers, and X-ray tubes which have become unfit for use due to the burning out of the filaments.
2. Manufacture of interchangeable ground joints for the use of scientific workers.
3. Manufacture of mercury diffusion vacuum pumps.
4. Manufacture of complicated table-blown glass apparatus not easily available in the country.

The laboratory has already done considerable amount of exploratory work, and over a dozen rectifier valves have already been reconditioned for the A.I.R. These reconditioned valves have been in use for periods up to 1,000 hr. and are still in service in perfect condition.

India is importing several hundreds of X-ray tubes every year and once the filament is burnt out, these tubes have to be discarded. It has been found possible to recondition these tubes in the same way as radio tubes. A certain amount of preliminary work has already been done in this connection and further work will be undertaken as soon as the large induction furnace is installed.

The laboratory is also making for its own use all the interchangeable ground joints needed. In addition, several laboratories have been supplied

special glass equipment making use of these interchangeable joints. Arrangements are under way to expand the production.

The section has made a number of glass apparatus, a few of which are listed here: (1) Various kinds of diffusion pumps, (2) vacuum gauges, (3) Macleod gauges, (4) distillation apparatus, (5) fractionation unit, (6) mercury cathode electrolytic apparatus, (7) water-cooled mercury arc, (8) chromatographic tubes, (9) air permeability tubes, (10) soxhlet apparatus, (11) interchangeable standard ground joints, (12) vacuum stopcock, (13) colorimeters and (14) vapour pressure apparatus.

Mr. F. Kiss, incharge of this work, is a glass technologist of considerable experience. A number of young apprentices in glass-working technique are under training. With the experience gained, it is hoped that it would be possible in the course of time for the laboratory to manufacture completely new valves and X-ray tubes, thus setting up a new industry in the country. Also a number of highly trained glass technicians will become available.

WORKSHOP

The workshop of the laboratory, one of the largest and best equipped in any scientific or educational institution in India, was engaged during the early stages in reconditioning machines obtained from disposals and from reparations and in making necessary spare parts for putting them into operation. The machines are now engaged in building scientific instruments. Two fork lifts have done valuable service in transferring and fixing the heavy machinery.

Several precision machines have been obtained and the quality of work is being continuously improved. The foundry is equipped with a 2-ton cupola and a large bed. A pneumatic hammer has been installed in the smithy section. An electroplating section and an electrical section with facilities for winding transformers, chokes, etc., have also been organized.

During the last few years the workshop has completed the fabrication of many scientific instruments. The total number of jobs handled by the workshop (till the end of November 1953) were 6,124, of which 370 were major items. Early in 1951 a map rack was designed and fabricated. This mechanical-cum-electrical gadget called for accurate machining and fitting work with suitable relays for automatic operation and was housed in a cabinet.

The workshop has undertaken the fabrication of a number of apparatus for other laboratories and for outside agencies including (1) automatic fraction collector for the National Chemical Laboratory, (2) pilot tube for the Hydraulic Research Station, Pathankot, (3) turning journal of press roller and the fabrication of bearings for the *Indian News Chronicle*, (4) spinning disc apparatus for the Malaria Institute of India, and (5) BCG vaccine container for the World Health Organization.

Special efforts are being made to improve metal finishing. Anodizing, plating, crinkle finishing, metallizing and sand blasting are all adopted for obtaining better finish.

Due to non-availability of trained personnel, a systematic apprenticeship scheme was started with a permanent sanctioned strength of 30 apprentices. The scheme has provided trained mechanics to the workshop and to various divisions. The apprentices and the other workshop staff are given regular technical and safety precaution lectures.

The following projects are under development: (1) lapping machine for the production of optical slits and rotary vacuum pumps, (2) cheap type of film slide projectors and tracelets for graduating machines, and (3) volumetric graduation machine.

The workshop also intends to take up the development of instruments like cheaper grades of projection lenses, improved electrical bridges, potentiometers, magnetic testing equipment, etc.

INK UTILIZATION PROJECT

Research work for the production of stamp cancelling ink required by the Department of Posts & Telegraphs, cyclostyle machine ink, newsprint ink and other oil based inks was completed on a laboratory scale at the C.S.I.R. Delhi Laboratories. It was decided that the Council of Scientific & Industrial Research should run the project on a pilot plant scale on behalf of the Ministry of Industry & Supply. Production was started in October 1950. The project was transferred to the administrative control of the Director, National Physical Laboratory, towards the end of 1952.

During 1952-53 an extensive programme of research was undertaken to remove defects and to improve the quality of duplicating ink. A satisfactory ink was developed using castor oil base. A considerably cheaper mineral oil based ink has recently been developed. This ink has stood the laboratory tests satisfactorily and has been approved by the Deputy Controller of Stationery, Calcutta.

So far the unit has been supplying ink for Government requirement. Besides this there is a large market demand for duplicating inks of the type used in Gestetner and other similar duplicators. The unit has recently been provided with a new edge runner for grinding. A colloidal mill is being installed and an automatic tube-filling machine is expected to be added shortly.

Technical Aid to Industry

Sixty-five industries have been advised on testing of compression and tension springs for bicycle and bicycle top saddle springs; composition, manufacture and heat treatment of spanners; types of steel for clutches; a substitute heat treatment; improvement in design of revolution counters; testing of steel rockers; testing of bamboo reinforced concrete panels; gold colouring, and brazing of tubes for cycle frames; testing of exhaust fans; etc.

Commercial tests have been carried out on (1) calibration of velometers, (2) vacuum flasks, (3) thermal conductivity, (4) thermometry, (5) fuel and lubricating oils (6) producer gas plants and (7) performance of agricultural tractors.

Tests were carried out on motor and diesel fuel engine pump oils and thermal conductivity of rubber samples.

Post office boxes, resistance boxes and unit resistances have been tested for several manufacturers. Indicating instruments, d.c. and a.c., have been calibrated for firms, Government organizations and electricity supply authorities.

R.F. ammeters have been tested for frequency errors. Mica condensers for filter circuits have been tested for temperature coefficient and

dielectric loss. Insulation and breakdown tests have been carried out on cables for manufacturers. Breakdown tests have been carried out on several insulating materials. Complete tests were carried out on several makes of storage batteries on behalf of civil aviation authorities. Tests have been done and advice tendered to manufacturers on a variety of products like electric horns, switches, heaters, instruments, etc. There is a growing demand from manufacturers of scientific instruments for calibration of electrical instruments.

Lamps were tested to B.S. Specification 1050 and a report was sent to the Ministry of Supply.

Colour temperature was determined from the ratio of energy at two wavelengths — one in red and the other in blue.

At the instance of the New Delhi Municipal Committee Electricity Department, a Foot Candle Meter for the purpose of carrying out surveys of street lighting has been designed and supplied.

At the instance of the Sugar Committee of the Indian Standards Institution, a photoelectric method is being devised for determining the quality of sugar from colour measurements.

NATIONAL CHEMICAL LABORATORY OF INDIA, POONA

THE foundation-stone of the National Chemical Laboratory was laid by Shri B. G. Kher, Chief Minister of Bombay State, on 6 April 1947. Consequently on the amalgamation of the Chemical Section of D.S.I.R.'s Laboratories with it, the Division of Biochemistry moved into the incomplete building in March 1949 and started work. The laboratory was formally opened by Shri Jawaharlal Nehru, Prime Minister of India, on 3 January 1950, on the occasion of the Poona Session of the Indian Science Congress, other divisions having also moved from Delhi in the meanwhile.

Scope & Functions

The scope and functions of the laboratory embrace all the chief applications of chemistry with due attention to fundamental research itself and include (1) survey of raw materials and their industrial potentialities, (2) development of new industries, (3) utilization of byproducts of existing industries, (4) fundamental research and application of results of fundamental research to problems of industry, (5) analysis and testing, (6) advice to industries by provision of information and advice and where necessary experiment and demonstration of industrial operations, and (7) training of research workers in specialized fields of chemistry and technology, particularly in fields in which facilities are not available in existing scientific institutions.

The technical work of the laboratory is divided into several divisions dealing with (1) Biochemistry, (2) Organic Chemistry, (3) Inorganic Chemistry, (4) Physical Chemistry, (5) Plastics and Polymers, (6) Chemical Engineering and (7) Survey and Information. An Administration Division has also been constituted to deal with financial and administrative matters.



NATIONAL CHEMICAL LABORATORY
POONA

The staff of the laboratory consists of one Director, one Deputy Director, 5 Assistant Directors, 13 Senior Scientific Officers, 21 Junior Scientific Officers and a complement of scientific assistants and ancillary technical staff. An Assistant Director (Administration) and an Administrative Officer assist the Director in the discharge of his administrative duties.

Programme of Work

Items of research in hand include the following:

BIOCHEMISTRY DIVISION

1. Citric acid fermentation
 - (i) Carbohydrate metabolism in *Aspergillus niger* and submerged fermentation
2. Dextran fermentation
3. Microbiological production of sulphur
4. Polysaccharides from mucilages as raw materials for fermentation industries
5. Microbiological method for liberation of starch from tubers
6. Fundamental studies on proteins with practical bearing on artificial fibres and pharmaceutical products
7. Transfusion gelatin
8. Preparation of amino acids from cheap raw materials
9. Protein metabolism and physiological effects of dietary protein
10. Studies of proteases, pectinases and oxidative enzymes
11. Preparation of industrial enzymes for desizing, bating, clarifying and coffee curing
12. Bactericidal compounds based on fatty acids from Indian oils and fats
13. National Collection of Type Cultures: collection, maintenance and distribution of micro-organisms of scientific and industrial importance
14. Development work on fermentations
 - (i) Citric acid
 - (ii) Calcium gluconate
 - (iii) Dextrin
15. Fermentative production of intermediates in cortisone synthesis

CHEMICAL ENGINEERING DIVISION

16. Catalytic dehydration of alcohols
17. Structure of carbon blacks
18. Effect of physical properties and chemical composition on calcination of limestones
19. Influence of trace impurities on the stability of hypochlorites

20. Smelting of phosphatic nodules and production of triple superphosphate
21. Chlorination of sewage gases
22. Utilization of sulphur from gypsum
23. Fluidized-bed oxidation of pyrites
24. Studies in the structure and regeneration of nickel catalysts
25. Pilot plant development of a modified vitamin C synthesis
26. Enzymatic release of tuber starches
27. Quaternary ammonium base antibacterials

INORGANIC CHEMISTRY DIVISION

28. New inorganic fertilizers and related materials
 - (i) 1. Mixed nitrogen-potash fertilizers by ammoniation of bitterns. Recovery of "light" magnesia
 2. Ammonium sulphate and "light" magnesia from epsom salt, ammonia and carbon dioxide
 - (ii) 1. Mixed nitrogen-phosphorus fertilizers from phosphate rock, hydrochloric acid and ammonium sulphate
 2. Thermal solubilization of phosphate rock by alkali and alkaline earth salts in sea bitterns
29. Rare metals
 - (i) Germanium and its compounds
 - (ii) Titanium and its compounds
 - (iii) Zirconium and its compounds
30. Chlorination of monazite and Nepalese sphalerite
31. Magnesium oxychloride
32. Catalytic studies on the stability of hypochlorite solutions
33. Pure selenium from crude sources
34. Instrumental methods — polarography, flame photometry, spectrography and measurement of radioactivity
35. New analytical methods

ORGANIC CHEMISTRY DIVISION

36. Study of the molecular structure of some natural products
 - (i) Pristimerin — colouring matter from *Pristimera indica*
 - (ii) Alkaloids from *Gloriosa superba*
 - (iii) Bitter constituents of *nim*
 - (iv) Swertinin, decussatin, and rubrofusarin (xanthones of natural origin)
 - (v) New terpene from *Mentha viridis*
37. New applications of some modern reagents
 - (i) Boron trifluoride
 - (ii) Lithium aluminium hydride (for reduction of anthoxanthins)
38. α -Substitution in the resorcinol nucleus

39. Structural studies and synthesis of dyes of the tetraphenyl ethane group
40. Sugarcane wax
 - (i) Chemical composition of crude and modified wax
 - (ii) Sterols from sugarcane wax
41. Study of the mechanism of saline extraction of oils
42. Synthesis of weedicides (scheme from the Indian Council of Agricultural Research)
43. Chemical investigation of some Indian essential oils
44. Synthesis of musk-like aromatics from Indian vegetable oils
45. Identification of vegetable oils (scheme from the Central Oilseeds Committee)
46. Improvements in the preparation of hydroxystearic acid and hexadecamethylene 1 : 16-dicarboxylic acid from *kamala* oil and their conversion into chemicals of industrial value
47. Utilization of *kamala* oil and some other cheap oils for paints and varnishes
48. Stabilization of edible oils by spices and condiments

PHYSICAL CHEMISTRY DIVISION

49. Determination of osmotic coefficient and molecular weight by means of thermistor technique
50. Preparation of a stable suspension of technical DDT
51. Electrophoresis of colloidal solutions
52. Light scattering by colloidal solutions
53. The spinning top ultra-centrifuge
 - (i) Physical and crystal-chemical studies of soap-like molecules such as alkyl malonic acids
 - (ii) Crystal structure studies of oxamic, malonamic, succinamic acids, etc.
54. Electron microscopy
 - (i) Polishing, anodic oxidation and protection of metal surfaces
 - (ii) Electrodeposition of metals, control of crystal growth and habit, and study of the structure of surfaces, films and particles
55. Study of solid-solid reactions
56. Optical micrography
57. Growth of single crystals
58. Molecular structures of organic compounds by infra-red absorption spectroscopy
59. Photographic emulsions
60. Instrumentation

PLASTICS & POLYMERS DIVISION

61. High polymers
 - (i) Properties of macro-molecules in solution

- (ii) Chain transfer in solution polymerization of monomers
- (iii) Molecular structures and physical properties of high polymers
- (iv) Study of polymerization and co-polymerization reactions
- (v) Polyelectrolyte soil conditioners
- 62. Rubber
 - (i) Study of the mechanisms of halogenation, hydro-halogenation and vulcanization of rubber
 - (ii) Physical chemistry of natural rubber latex
 - (iii) Improvement of the solvent resistance of natural rubber
 - (iv) Ion-exchange resins as catalysts in organic reactions
- 63. Ion-exchange resins
 - (i) Synthesis of ion-exchange resins and membranes of improved regeneration efficiencies
 - (ii) 1. Study of ion-exchange resins in mixed and non-aqueous media
 - 2. Ionic fractionation with membranes
 - (iii) De-ionization of cane juice and de-fluorination of water
- 64. Integration of flake mica into sheet form
- 65. Mechanical behaviour of soft core laminates

Items of new research proposed to be undertaken include the following

BIOCHEMISTRY DIVISION

- 1. Fermentative production of
 - (i) Vitamin B₁₂
 - (ii) Intermediates for musk perfume synthesis
- 2. Structural changes in proteins during enzymic digestion
- 3. Isotopic tracer studies on
 - (i) Nitrogen metabolism
 - (ii) Carbohydrate metabolism in *Aspergillus niger* with special reference to citric acid production
- 4. National Collection of industrial micro-organisms

CHEMICAL ENGINEERING DIVISION

- 5. Pilot plant scale studies on the calcination of Indian limestones
- 6. Fundamental studies on fluidization and distillation
- 7. Projects for pilot plant scale development from other divisions to the laboratory

INORGANIC CHEMISTRY DIVISION

- 8. Tracer studies with radioactive isotopes
- 9. The study of solid-solid reactions

10. Manganese dioxide depolarizer from Indian manganese minerals
11. Studies in the isolation of rare earths from Indian monazite
12. Chemical spectroscopy
13. Fluorine and fluorination of compounds
14. Organic derivatives of silicon, titanium and phosphorus
15. Inorganic micro and ultra-micro analysis

ORGANIC CHEMISTRY DIVISION

16. Synthesis of vitamin A (assignment from the Ministry of N.R. & S.R.)
17. Pilot plant studies in the refining of *nim* oil
18. Utilization of cheap vegetable oils as lubricants (scheme from the Central Oilseeds Committee)

PHYSICAL CHEMISTRY DIVISION

19. Mechanical wear and lubrication with special reference to indigenous oils and fats
20. Growth of single crystals

PLASTICS & POLYMERS DIVISION

21. Synthesis and application of silicones
22. Preparation of allyl starch and study of its use in coatings
23. Non-absorbent cellular rubber for packing and other applications
24. Development of wrinkled rubber films
25. Light scattering by polymer solutions

Progress of Research

The laboratory has been engaged on work leading to industrial utilization of the natural resources of the country by discovery of new processes and products and also in obtaining the "know-how" of industrial processes already established in other countries.

UTILIZATION OF MINERALS

1. *Rock Phosphate* — The only phosphatic fertilizer manufactured in India today is single superphosphate (18-28 per cent phosphorus pentoxide) which requires nearly equal quantities of sulphuric acid and rock phosphate. At the instance of the National Planning Commission, a neutral phosphatic fertilizer, dicalcium phosphate, containing 40-42 per cent available phosphorus pentoxide (citrate-soluble), which is free-flowing neutral powder with good keeping qualities, has been developed on a pilot plant scale using Kossier rock phosphate and hydrochloric acid. The

fertilizer is now undergoing field trials at the Indian Agricultural Research Institute, New Delhi, and Madras. Dicalcium phosphate, containing about 4 per cent calcium fluoride, has also been prepared from Trichinopoly phosphatic nodules by a similar process. Semi-acidulated phosphate, the *Kotka* type has been prepared from rock phosphate by using a little over half the quantity of sulphuric acid required for the manufacture of superphosphate.

A new mixed nitrogen-phosphorus fertilizer, containing 7.4 per cent nitrogen and 15 per cent phosphorus pentoxide, has also been prepared from rock phosphate, ammonium sulphate and hydrochloric acid.

All these processes aim at effecting considerable savings in the consumption of sulphuric acid.

2. *Ilmenite & Rutile* — Current developments in metallurgy of titanium and industrial applications of titanium compounds are of great significance to India because of its almost unlimited reserves of ilmenite and rutile ores. Optimum conditions have been established for the preparation of titanium tetrachloride on a pilot plant scale by chlorination of rutile and ilmenite. Titanium dioxide of high pigment quality has been obtained from titanium tetrachloride. Preparation of titanium dioxide by this method has the obvious advantage of utilizing chlorine, a byproduct of the electrolytic caustic soda industry, and dispensing with the use of sulphuric acid.

3. *Monazite* — Conditions have been worked out for the decomposition of unground monazite sand by chlorination. A recovery of rare earths to the extent of 99 per cent and of thorium 84 per cent has been achieved. Thorium and rare earth salts find extensive application in incandescent lamp mantle industry and in metallurgy. Preparation of individual rare earths and of thorium in a high state of purity is in progress.

4. *Zircon* — Zircon is an important mineral occurring in Travancore. Zirconium compounds are largely used in refractories, ceramics and nuclear research. Work on the decomposition of unground Travancore zircon and on extraction of iron-free zirconia has been completed. A volumetric method for the estimation of zirconium in solutions and in Indian zircon has been worked out.

5. *Sphalerite* — Investigations on the extraction of Nepalese sphalerite ore (0.04-0.16 per cent germanium dioxide) are being carried out in collaboration with the National Metallurgical Laboratory, Jamshedpur. A volumetric method for the estimation of germanium in flue dusts and minerals has been worked out. New germanium compounds of abnormal valency states have been synthesized.

UTILIZATION OF INDUSTRIAL WASTES & BYPRODUCTS

1. *Aluminium Chloride from Aluminium Scrap* — A process using aluminium scrap and byproduct chlorine has been developed on a pilot plant scale for the preparation of anhydrous aluminium chloride, an important catalyst in the manufacture of synthetic dyes, drugs, plastics and in the manufacture of galvanized iron. The process and design of the equipment have been made available to a local firm.

2. *Nicotine from Tobacco Wastes* — It is estimated that about 4.5 million pounds of tobacco waste is available every year in India. Preparation of nicotine sulphate, an effective insecticide against green fly, white fly and snails and also the basic material for the preparation of nicotine

acid and nicotinamide, from this waste has been developed on a pilot plant scale. Test reports on the efficiency of nicotine sulphate produced have been favourable. Pilot plant studies have shown that nicotine sulphate can be produced in India with simple equipment. The process is covered by patents in India, Cuba, U.S.A. and Turkey.

3. *Mixed Fertilizers from Salt Bitterns* — Detailed investigations have been carried out on the use of raw bitterns, a waste material from the sea salt works. Simultaneous ammoniation and carbonation of the sea bitterns gave a crystalline soluble nitrogen-potassium fertilizer containing 21 per cent nitrogen (mixture of ammonium sulphate and chloride) and 3 per cent potash. Field experiments are in progress to establish the efficiency of the material as a fertilizer. Pure magnesium carbonate of pharmaceutical grade is also obtained as a byproduct and under suitable conditions yields a pure white, light magnesia which finds use as a thermal and electrical lagging material. The process has recently been extended to the preparation of pure ammonium sulphate using epsom salt as the raw material.

4. *Titanium from Red Mud* — Bauxite sludge, commonly known as red mud, a waste product of the alumina or aluminium sulphate industry, has been chlorinated for the recovery of titanium as titanium tetrachloride and converted into the white pigment, titanium dioxide. Large quantities of titanium can be recovered by this process by alumina factories.

5. *Chlorinated Rubber* — Chlorinated rubber has been successfully produced on pilot plant scale from certain types of rubber waste. The process provides a profitable outlet for India's surplus chlorine. A heavy demand for chlorinated rubber for acid and alkali resisting paints and varnishes for defence purposes and for the heavy chemical industry is anticipated and its production in the country would be of great advantage. The details of the process have been made available to one of the leading chemical firms in India.

6. *Alcohol from Bagasse* — In collaboration with Shri Ram Institute for Industrial Research, Delhi, and at the instance of the special Committee of the Board of Scientific & Industrial Research, work was carried out to investigate the possibility of utilizing bagasse, a sugar industry waste, for alcoholic fermentation. Several strains of *Saccharomyces cerevisiae* were found to be capable of fermenting bagasse hydrolysate, which was shown to contain about 90 per cent reducing sugars and 10 per cent pentoses. Alcohol yield was about 35 per cent of the sugar utilized. From the practical point of view, this problem requires further investigation with special reference to yeasts capable of fermenting pentoses or of preparing pentose-free hydrolysates. Using ion-exchange resins, Amberlites IR-4B and IR-100, crystalline glucose has been obtained from the bagasse hydrolysate.

7. *Sugarcane Wax* — Crude sugarcane wax, another byproduct of the cane sugar industry, has been refined and chemically modified to serve as a substitute for carnauba wax with respect to solvent take-up and solvent retention properties.

8. *Amino Acids & Protein Concentrates* — Cheap sources of proteins have been utilized for production of valuable amino acids. Glumatic acid, largely used in medicine and in food industry, has been produced from groundnut cake. A process has also been developed for elimination of saponin from *mahua* oil cake with a view to making it suitable for use as a fertilizer and as a cattle feed. The purified cake has been supplied to the Agricultural College, Poona, for field trials.

Anaerobic digestion of leafy wastes by *Clostridium roseum* has been used for the preparation of carotene-protein concentrates suitable as human food. The protein concentrates from leaves of sweet potato, *Ipomoea* and alfalfa have been found to have a biological value superior to that of casein, although their digestibility coefficients are rather lower.

9. *Microbiological Production of Sulphur* — Production of sulphur by anaerobic digestion of biological wastes has been attempted with a view to exploring alternative sources of sulphur. Digested sludge obtained from sewage purification works at Dadar, Bombay, has been employed as the raw material. Experiments have been mainly directed to increase sulphate reduction during anaerobic digestion of municipal sewage with production of methane for use as gaseous fuel. During methane fermentation, small quantities of hydrogen sulphide are formed and in some cases sulphur is recovered from methane by passage through iron oxide scrubbers. Work has been carried out on increasing hydrogen sulphide formation by adding to the raw sludge, before digestion, sulphate in insoluble and soluble forms and, production of sulphur by inoculation with sulphate reducing bacteria.

RESEARCHES ON UNEXPLOITED OIL RESOURCES OF THE COUNTRY

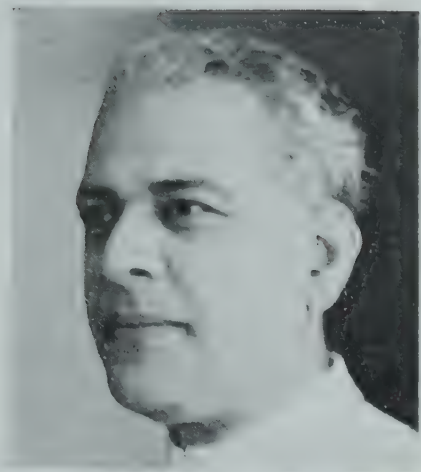
1. *Vegetable Oils* — Considerable work has been done on the utilization of non-edible oils for industrial purposes. Successful methods have been worked out for refining of such oils as *nim*, *karanja*, *nageshwar* and cotton seed. The industrial exploitation of these oils, particularly *nim* oil, should replace a large quantity of edible oils now consumed in soap and other industries. The refined *nim* oil has also been found to be a rich source of technical oleic acid and stearin. The bitters of *nim* oil have been separated into a series of compounds likely to be of medicinal value. Processes for utilization and refining of *nim* oil have been patented.

Amongst the non-edible drying oils, *kamala* and tobacco-seed oils have been studied for use in paints and varnish industry. Varnishes prepared from *kamala* oil are comparable to those of tung oil and are likely to find extensive use for decorative wrinkle finishes as they do not require any baking as is the case with wrinkle varnishes in general use. The details are covered by a patent.

Baking enamels with good gloss, adhesion, flexibility and water resistance have been developed from tobacco-seed oil, phthalic anhydride and glycerine. These enamels can be prepared as plain and wrinkle finishes and should find large application in this country. Both high and low temperature plain baking finishes with improved characteristics have been prepared by fortification of tobacco oil-modified alkyds with alkylated urea-formaldehyde resins. Experiments on the study of texture control in wrinkle finishes from these enamels have shown that solvent naphtha could be used as a thinner for such compositions. The compositions have been patented.

Under suitable conditions, castor oil has been converted into heptaldehyde and undecylenic acid which are valuable in synthesis of essential oils and synthetic aromatics. Work has also been done on hydrogenation of castor oil and optimum conditions for the preparation of 12-hydroxy stearic acid, which is now in demand as a constituent of multipurpose greases in lubrication of jet planes, have been worked out.

A simple process for the extraction of castor oil from castor seed through an aqueous medium has been developed. The yield of the oil



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obtained by this method is 42-43 per cent as against about 40 per cent by usual expression methods. The process has been patented.

2. *Essential Oils* — A number of essential oils like spearmint, Malabar lemon grass oil and *Pinus khasya* oil have been examined. A process has been standardized for the isolation of the essence of tuberose by the enfleurage method. Synthetic aromatics like cinnamyl alcohol and cinnamyl acetate have been prepared from cinnamic aldehyde and conditions standardized. The spearmint oil has been obtained from the plants grown on the NCL estate in a yield of 44-60 pounds per acre (cf. American oil yield 30-40 pounds per acre). This oil appears to be different from the American product, as it does not seem to contain any carvone, the most characteristic constituent of American oil. A new terpene has been isolated from Indian spearmint oil and its structure has been established.

3. *Animal & Other Oils* — Quaternary ammonium compounds have now become bactericidal substances of widespread use and of great importance. Using fatty acids obtained from hydnocarpus and shark-liver oils, new bactericidal compounds have been synthesized.

GELATIN

1. *Gelatin from Bones & Hides* — Nearly 45,000 tons of bones and about 1,500 tons of raw hides are exported every year from India, while all high grade gelatin required in the country is imported. A process utilizing bones and raw hides for the preparation of gelatin and glue has been successfully worked out on a pilot plant scale. The average yields of gelatin and glue were 28 per cent and 25 per cent on the weight of dry hides. The gelatin obtained was tested and found comparable to the imported material. The process for the preparation of gelatin has been patented and leased out to a firm. Technical assistance is being given to the firm to enable it to install and operate a factory.

2. *Photographic Emulsions* — Photographic films and papers are consumed in fairly large amounts in this country, and are at present imported. Processes for making negative and positive emulsions, using gelatin made in the laboratory from hides and bones, have been completed, and are being finalized for large-scale development.

3. *Transfusion Gelatin* — Experiments on preparation of gelatin as a plasma substitute in blood transfusions are nearing successful completion. The use of gelatin as a transfusion material has been more than once attempted but the high viscosity of gelatin solutions has presented great difficulties. Attempts to reduce the viscosity are usually accompanied by lowering of the molecular weight of the gelatin thus detracting from its value in maintaining blood pressure. However, by a new process developed in the laboratory, it has been possible to produce a gelatin which combines the characteristics of low viscosity and high molecular weight. Animal experiments carried out in collaboration with the Armed Forces Medical College, Poona, have given promising results on its use as a plasma substitute.

CHEMICAL EXAMINATION & ISOLATION OF PLANT PRODUCTS

1. *Alkaloids* — Investigations on isolation and chemical examination of alkaloids of *Alangium lamarckii*, *Gloriosa superba* Linn. *Tabernaemontana dichotoma* and *Lawsonia alba* have been completed. *Alangium*

lamarckii has yielded an amorphous alkaloid which appears to bear some relationship to the emetine group of alkaloids. An alkaloid and a crystalline sterol have been isolated from the bark of the plant *Taternia indica dichotoma* which is used as a drug. An alkaloid, colchicine, which finds use in medicine and in the production of polyploid varieties of many plants, has been isolated from tubers of *Gloriosa superba*. A process has been developed for the isolation of lawsone from *Lawsonia alba* leaves.

The chemistry of pristimerin, an antibiotic isolated from *Pristimera indica* or *Pristimera grahmi* by some other workers, is being actively investigated and some basic points in its structure have been established. Investigations on the chemical constitution of physiologically active latter constituents of *nim* are also being carried out.

2. *Soapnuts & Shikakai*—Simple and economical processes have been worked out for extraction of saponins from soapnuts and shikakai. There is no indigenous manufacture of saponins although they have a variety of uses, particularly in the textile industry. The processes are covered by a patent.

3. *Starch from Tuberous Materials*—Starch is an industrial chemical and a raw material for many fermentation industries, the annual consumption of starch for the textile industry alone being estimated at 75,000 tons. However, the current cereal shortage in the country has hit the starch industry severely and India's starch requirements have been met either by imports or by manufacture from imported grain. A new process has been developed in which an enzyme produced by micro-organisms can be used for the liberation of starch from tubers like tapioca. This process is expected to simplify manufacture of tuber starch. Detail for production of glucose from starch have been completely studied.

4. *Ramie Fibres*—At the request of the Fibre Development Officer Government of Bombay, biochemical and chemical methods have been worked out for degumming ramie stalks. Out of the various micro-organisms tried, *B. subtilis* has been found to be effective, and among commercial enzyme preparations, *Pectinol 100D* and *Pectinol A* have been found suitable. The sample of ramie has been tested and reported to be satisfactory.

5. *Cashew-nut Shell Liquid*—An enamel has been prepared from cashew nut shell liquid by blowing the material in the presence of catalysts. The enamel may find use for internal coating of containers, for oils and food products and for lining equipment in fermentation processes.

6. *Bhilawan Nut Shell Liquid*—Bhilawan nut shell liquid has been used for the preparation of certain finishes for rubber shoes, gum boots and other rubber articles.

Ion-exchange resins have been developed from cashew-nut and bhilawan nut shell liquids, naphthalene and coal. These resins are likely to find extensive use in various fields such as softening and de-ionization of water, increased recovery of sugar from cane juice and molasses and recovery of certain metallurgical wastes.

7. *Rubber Latex*—Compositions based on natural rubber latex for sealing seams of cans used for storage of oils and food materials have been formulated and reported to be satisfactory by the industry.

The colloidal nature of rubber has been advantageously used in stabilizing pigment dispersions in various industrial compositions, such as paints and duplicating inks. Oil based compositions of paints, duplicating inks, etc., demand that the rubber used must be compatible with the composition. Solid rubber, however, does not mix with such composition.

unless it is degraded and depolymerized to an extent when the molecular weight approached 1,000-2,000. Polyisobutylene and polymethyl pentadiene of the same molecular weight range show similar behaviour. Satisfactory compositions were prepared for inks (duplicating) and inside wall paints.

At the request of a Calcutta firm, investigations were successfully undertaken to improve the life and physical properties of cotton and hair beltings up to 5 mm. thickness by impregnation with latex. Large-scale trials are in progress.

SYNTHETIC PREPARATIONS

1. *Organic Compounds* — Various iodo-acridine derivatives of atebtrin type of possible value as antiseptics or antimalarials have been synthesized.

Laboratory studies on the oxidation of nicotine sulphate to nicotinic acid, an important factor of vitamin B complex, have been carried out.

Conditions have been worked out for preparation of benzaldehyde and benzoic acid, used largely in the pharmaceutical and perfumery industry from chlorine and toluene.

Applications of lithium aluminium hydride for reduction of anthoxanthins and of boron trifluoride for Pechman condensation have been studied.

A number of quinonyl coumarins have been synthesized for use as intermediates for preparation of new antimalarials. Under a scheme financed by the Indian Council of Agricultural Research, work on the preparation of synthetic weedicides has been started.

2. *Biochemical Products* — A simple enzymic process has been developed for the production of calcium gluconate from glucose and starch hydrolysate.

Citric acid and citrates are important chemicals used mainly in pharmaceutical, food, dyeing and calico-printing industries. Citric acid is now manufactured almost entirely by mold fermentation. India's requirements of citric acid are met entirely by imports. Investigations on citric acid fermentation of glucose and sucrose have resulted in the isolation of a good strain of *Aspergillus niger* with outstanding citric acid producing ability, and in establishing the conditions under which this fungus can be employed for commercial production of citric acid. The fungal mycelium, obtained in the process, has been used in the production of calcium gluconate. The yield of citric acid in terms of the weight of the material used is 70 per cent with glucose and 50 per cent with cane sugar.

Complete details have been established for the synthesis of vitamin C from starch. One step in the synthesis in this useful pharmaceutical consists in the conversion of the sugar alcohol sorbitol into the sugar sorbose. A new process has been developed for this conversion and covered by a patent.

Micro-organisms have also been used for the production of a number of industrially valuable enzymes. These include enzymes for clarification of fruit juices, for desizing of textiles and for a new method of coffee curing. New proteolytic enzymes of possible use in preparation of protein hydrolysates and other similar purposes have also been prepared.

3. *Synthetic Crystals* — Natural gem stones of ruby, sapphire, and rutile used in ornaments and as bearings in watch industry are being

replaced on an increasing scale by synthetic ones. Process for growing such gem crystals are being developed.

4. *Inorganic Preparations* — Sodium tripolyphosphate is an important detergent material used in water-softening, and washing compositions, and in soap manufacture. Although it is not manufactured in India at present a good scope exists, especially now when the chief raw materials, namely trisodium phosphate and phosphoric acid are manufactured in the country. A process has been worked out for the preparation of sodium tripolyphosphate in a crystalline form identical with that of the imported product. The process has been patented.

GENERAL SERVICES

The application of modern analytical techniques including micro-analysis is a feature of the service analyses carried out by this laboratory for industry and research organizations. These include chromatography, flame photometry, polarography, emission spectrography and measurement of radioactivity by Geiger counters. Facilities exist for learning these techniques.

The electron diffraction apparatus recently set up will help in solving various structure problems relating to electro-deposition, electro-polishing and lubricating.

The infra-red spectrograph and the X-ray diffraction equipment are being used for identification of unknown complex organic compounds.

Aid to Industry

On an average, 125 enquiries on technical subjects are received from industry and attended to every month.

Development of researches to the pilot plant stage is carried out in the Division of Chemical Engineering for the benefit of those who desire to start large-scale industries. Detailed projects are prepared and demonstrations arranged for parties interested in small-scale and cottage industries.

A separate laboratory is maintained for solving short-term *ad hoc* problems for industry.

Departments of Industries in all the States are supplied with detail schemes on industrial processes in connection with their development schemes for towns and villages.

NATIONAL METALLURGICAL LABORATORY JAMSHEDPUR

THE National Metallurgical Laboratory was officially opened by the Prime Minister, Shri Jawaharlal Nehru, on 26 November 1950. The Metals Research Committee recommended, as early as 1940, the establishment of a National Metallurgical Laboratory. The Governing Body of the Council accepted this proposal, and the foundation-stone was laid by Shri Chakravarti Rajagopalachari, then Minister for Education & Arts in the Interim National Government, on 21 November 1946.

Donations

The following donations have been received from various parties towards the capital expenditure of the institute.

Sir Ratan Tata Trust ...	...	Rs. 12.0 lakhs
Sardar Bahadur Sir Indra Singh ...	...	Rs. 1.0 "
Indian Metallurgical Association ...	...	Rs. 10,000 "
Tata Industries Ltd. ...	...	26 acres of land

Scope & Functions

The laboratory deals with different aspects of metallurgical research and constitutes an up-to-date research centre where knowledge of metallurgy, physics, chemistry engineering, etc., is utilized. The main functions of the laboratory are application of research results to commercial operating conditions; close collaboration with other research institutes and organizations, particularly on long-term research of a fundamental nature; testing and standardization of manufactured products, and tendering advice on the preparation of specifications appropriate to Indian conditions; collection of data and technical information to function as a clearing house for information; and providing facilities for solution of problems of industries.

Divisions

The activities of the laboratory are divided into six divisions working in close co-ordination: (1) General Metallurgy, (2) Physical Metallurgy, (3) Chemical, (4) Refractories, (5) Ore-dressing, and (6) Mechanical Metallurgy and Testing.

The staff consists of a Director, a Deputy Director, 3 Assistant Directors, 3 Senior Scientific Officers, and an Administrative Officer besides others.

Research Problems on Hand

APPLIED

1. Production of nodular cast iron and a study of nodularization
2. Properties of various foundry moulding sands

3. Preparation of aluminized steels
4. Preparation of Al-Si alloys by direct thermal reduction
5. Direct reduction of iron ore to yield variable density steels
6. Semi-pilot plant for production of electrolytic manganese
7. Deposition of metals on non-metals with nickel as the bonding layer
8. Brass plating from non-cyanide baths
9. Plating on aluminium and aluminium alloys
10. Reduction of manganese dioxide by glucose, molasses, sawdust, etc., in the presence of 2 per cent sulphuric acid
11. Electrolytic separation of nickel from silver refinery waste liquor
12. Reduction of titanium tetrachloride for the production of titanium
13. Preparation of zirconium metal
14. High temperature electrolysis of lead sulphide for recovery of elemental sulphur
15. Beneficiation of low grade graphite ore (Plumbago "A" quality)
16. Beneficiation of low grade uranium ores
17. Beneficiation of low grade manganese ore from Tirodi Mines, Madhya Pradesh (joint investigations with Indian Bureau of Mines)
18. Concentration of germanium from lead-zinc ores
19. Beneficiation of low-grade manganese ore fines from Shivrajpur Syndicate (joint investigations with Indian Bureau of Mines)
20. Basic refractories
21. Insulation refractories
22. Carbon refractories
23. Graphite refractories
24. Silicon carbide refractories
25. High temperature air corrosion of some manganese-aluminium steels
26. Electrical and magnetic properties of some low-manganese low-aluminium steels
27. Study of impact fatigue resistance of structural steels
28. Study of fatigue properties of structural steels and their notch sensitivity
29. Study of wear resistance of railway wheel tyres and rails

FUNDAMENTAL

1. Study of abnormality in Al-bearing and alloy steels through pack and gas carburization
2. Study of the properties of metal powders
3. Study of austenite decomposition — Bainite reaction in steels
4. Study of austenitic grain size control in plain carbon and alloy steels
5. Rapid method for the estimation of beryllium in beryl



NATIONAL METALLURGICAL LABORATORY OF INDIA
JAMSHEDPUR

6. Analytical method for the separation of titanium from iron and other metals
7. Flotation properties of manganese minerals
8. X-ray study of mechanism of fatigue cracks
9. Effect of the addition of tin to copper on the " dihedral angle " of copper versus low melting elements like arsenic, antimony, bismuth and lead
10. A study of upper and lower yield points
11. Dynamic determination of elastic constants and their variation with temperature
12. Study of variation of tensile properties with fatigue cycle

Research Problems Completed

1. Concentration of ilmenite sands from Orissa and Ratnagiri Coast
2. Beneficiation of low grade chrome ore from Dodkanya, Talur, Arsekere, Dodkatur (Mysore) and Kittaburu (Singbhum District, Bihar)
3. Some jari plating defects and their removal
4. Flotation of sulphur from sulphur-bearing clays
5. Concentration of low grade pyrite from Chitaldrug, Mysore; Karwar, Bombay; Ainjor, Bihar
6. Removal of nickel and zinc from silver refinery waste liquor
7. Study of austenitic grain size control of alloy steels (Ni-Cr) through aluminium additions
8. Observations on the structure of spheroidal graphite in nodular cast iron
9. Washing tests with Noamundi soft iron ore — haematite
10. Pilot plant spiral tests on batch Humphrey's spiral with soft and hard Kittaburu chrome ore
11. Beneficiation of low grade manganese ore from Kachidana and Mansor Mines, Madhya Pradesh (joint investigation with Indian Bureau of Mines)
12. Electrolytic production of high purity manganese dioxide
13. Production of low-carbon ferro-chrome
14. Production of electrolytic manganese
15. High temperature oxidation characteristics of some manganese-aluminium steels
16. Concentration of uranium-bearing flotation tailing from *Indian Copper Corporation, Ghatsila*
17. Thermal beneficiation of low grade manganese ore
18. Moulding sands for piston ring castings
19. Concentration of wolfram ore from Degana, Rajasthan
20. Beneficiation of low grade uranium ores from the Atomic Energy Commission
21. Beneficiation of auriferous pyrite from Wynaad, Nilgiris

22. Beneficiation of low grade cassiterite from Ranchi, Bihar, and tabling of a concentrate

UP-GRADING OF LOW GRADE ORES BY ORE-DRESSING & THERMAL METHODS

1. Metallic ores as found in nature often cannot be economically refined unless up-graded by mineral beneficiation or ore-dressing processes. Ore-dressing techniques for up-grading low grade chromite ores from Kittaburu (Bihar) and Talur, Dodkanya, Arsekere and Dodkatur (Mysore) were investigated. The work was completed.

2. Manganese ores are chiefly utilized for the manufacture of ferro-manganese, for which purpose ores with a manganese content of over 40 per cent can only be economically employed. At present, most of the high grade manganese ore is exported after sorting out the low grade ore. It is estimated that for every ton of high grade manganese ore mined, about equal or greater tonnage of low grade ore is discarded which is an economic loss because deposits of high grade manganese ores are not unlimited. For conserving India's deposits of manganese ores, low grade ore has to be processed and utilized. A suitable thermal beneficiation method for commercial utilization of low grade manganese ores has been developed and ore-dressing processes for up-grading of a series of low grade manganese ores have been evolved in collaboration with the Indian Bureau of Mines.

3. India is placed in a poor position in regard to reserves of sulphur — a vital industrial raw material. Investigations were initiated towards the concentration of low grade pyrites from Chitaldrug (Mysore), Wynaad (Nilgiris) and Karwar (Bombay) and initial work has shown that ores from Chitaldrug may yield about 15,000 tons of sulphur after suitable beneficiation.

4. Research work has been directed towards up-grading of low grade wolfram ore from Degana, Rajasthan. The ore assayed only 0.11 per cent WO_3 and was concentrated up to 66.3 per cent WO_3 , making possible economic production of marketable concentrate.

5. Of topical interest is the work being pursued on concentration of low grade uranium ores.

EXTRACTION & REFINING OF METALS & PREPARATION OF ALLOYS

1. Nodular cast iron, a recent innovation to improve physical properties of cast irons for use as an engineering material, is of importance in the background of shortage of steel in India. Iron foundries can utilize Indian pig iron for nodular cast iron castings. A project on "Production of Nodular Cast Iron and a Study of Nodularization" is under active investigation.

2. Existing methods of preparing Al-Si alloys are expensive for Indian conditions. Investigations were initiated on the production of these alloys for use in engineering and automobile industries by an unconventional process. The work has progressed successfully and patents will be filed to cover it.



NATIONAL METALLURGICAL LABORATORY —
SIR RATAN TATA TECHNOLOGICAL LABORATORY

CONSTITUTION & PROPERTIES OF METALS & ALLOYS

To study the morphological and structural changes in steel and to evolve suitable alloy steels in the light of Indian conditions and requirements, systematic work is being done on fundamental studies on the kinetics of transformation in steels.

DEVELOPMENT OF REFRACTORY MATERIALS FROM INDIAN RAW MATERIALS

1. Sillimanite refractories have a wide scope in India. Researches on Travancore beach sands as a source of sillimanite should be of great economic value, since at present Indian sillimanite is not effectively utilized. Initial experiments have established that it is possible to evolve suitable sillimanite refractories which will withstand much higher temperatures than other alumino-silicate refractories in use at present.

2. The use of carbon refractories is well established in the field of electro-metallurgical industries. A research project on the production of carbon refractories has been undertaken as it is expected that with the growth of electro-metallurgical industries in India the demand for this material will be greatly stimulated.

3. The use of silicon carbide refractories in high temperature ceramic technology is of recent growth. Its high thermal conductivity and good mechanical strength at high temperatures, besides excellent electrical resistivity, make it highly desirable for certain metallurgical applications. A project for the production of silicon carbide is under systematic study.

4. Work has been undertaken on the suitability of magnesite-talc rock extensively found near Chaibasa, Bihar, for the production of forsterite or forsterite-magnesite type of refractories. This refractory retains high load-bearing capacity and good mechanical strength at high temperatures. Investigations are under way to determine the desirability of making basic and super-duty insulation refractories from indigenous raw materials.

PLATING OF METALS & NON-METALS FOR INDIGENOUS INDUSTRIAL APPLICATIONS

Several plating problems relating to plating industry have been completed. Substitution of cyanide baths by non-cyanide solutions for electroplating of brass has been successfully developed and patented. Technique of plating metals on non-metals like glass, wood, porcelain, etc., has also been successfully developed and covered by patents. Chromium plating on aluminium is under study with a view to combine the light weight of aluminium with the wear and corrosion-resistant surface of chromium. This problem should be of special value to the automotive industry.

PHYSICAL, ANALYTICAL & OTHER TESTS

Satisfactory service performance is of primary importance to the industrial user of metals. Systematic examination of the physical properties of metals helps to determine the service life of a metal product, for

instance the wear performance of railway components like rails, tyres and wheels will determine their service life. Such subjects are being examined on a long-range basis. To aid industry analytical tests are undertaken.

PROBLEMS REFERRED BY METAL INDUSTRIES & GOVERNMENT ORGANIZATIONS

Research work on problems referred by industry and Government bodies entails exhaustive at site examination and evolution of processes to suit operational details. The work done on disintegration of Soderberg electrodes and on separation of cryolite from carbon dust produced in the aluminium reduction cells illustrates the importance of such type of work. Jari plating industry at Surat was experiencing difficulty in protecting the plating from colouration on burning. This problem was successfully tackled to the satisfaction of the industry.

Recovery of nickel and zinc from spent liquors obtained from silver and copper refineries formed the subject of a lengthy investigation which has been successfully completed.

Examination of service failures of metal components and devising suitable remedial measures help the engineering industry. Such problems are quite frequently referred to the laboratory and are being successfully solved.

Technical Aid to Industry

Normally all the work of the laboratory, with the possible exception of a few items of fundamental research, is in the nature of technical aid to industry. The general policy is to accept all possible items of work requested by industry either directly or through Government and whether financially aided or not.

As regards specific technical aid to industry, help is rendered in the form of (1) technical enquiries, (2) routine tests, and (3) short-term investigations.

Technical assistance has been rendered to a large number of industries including iron and steel works, mining and metallurgical industries, rolling mills, foundries, engineering works, non-ferrous metallurgical works, galvanizing works, collieries, etc. The main Government departments including Ministry of Railways, Ministry of Commerce & Industry, Metallurgical Inspectorate, Geological Survey of India, etc., have also sought the assistance of the laboratory.

FUEL RESEARCH INSTITUTE, JEALGORA

Introduction

THE Board of Scientific & Industrial Research constituted a Fuel Research Committee under the chairmanship of the late Dr. H. K. Sen in June 1940. At its first meeting in August 1940, the committee resolved that a Central Fuel Research Station for India should be established, a resolution duly supported by the Governing Body of the Council. The leading personalities in the movement for the creation of the Fuel Research Institute were Dr. S. S. Bhatnagar, Director, Scientific & Industrial Research, and Dr. H. K. Sen, Director of Industries, Bihar. Valuable support was also given by Sir Ardeshir Dalal, Member in charge of Planning & Development, Sir C. S. Fox, Director of the Geological Survey of India, and Mr. A. Farquhar of the Coal Department, *Tata Iron & Steel Co. Ltd.* The foundation-stone of the institute was laid on 17 November 1946 by Mr. C. H. Bhabha, Minister for Works, Mines & Power. Actual construction work was taken in hand in the winter of 1947, when funds became available. The institute was officially opened by Dr. Rajendra Prasad, President of the Indian Republic, on 22 April 1950.

Scope & Functions

The object of the Fuel Research Institute is to undertake research, both fundamental and applied, on solid, liquid and gaseous fuels. Although, for the present, the activities of the institute are necessarily confined to a large extent to solid fuels, coal in particular, and the liquid and gaseous fuels derivable from coal, it is the intention of the institute to extend this field in due course.

A major undertaking of the Fuel Research Institute is the physical and chemical survey of the coals of India. The object of this survey is to provide a reliable assessment of the quality and quantity of the coal resources of the country, in order to ensure that the different types of coal are utilized to the best advantage.

The work of the Fuel Research Institute covers broadly: (1) Assessment of the fuel resources in quantity and quality; (2) encouragement of the use of the different types of fuel for the purposes for which they are best suited; (3) improvements in fuel economy and especially in combustion technique; (4) improvements in solid fuel preparation and purification (including coal washing, screening, grinding, pulverizing, etc.); (5) carbonization of coal at high and low temperatures; (6) gasification of solid fuels; (7) hydrocarbon synthesis; (8) hydrogenation of coal and tars; (9) special problems in fuel utilization or treatment, e.g. benzol, coal tars, lignites, desulphurization, etc.; (10) fundamental studies in the composition, constitution, and properties of fuels and of their associated impurities; (11) spontaneous combustion and its prevention; (12) sampling, sizing, and similar investigations; and (13) analytical and other tests.

In addition to problems of fundamental and applied research, technical aid to the industry and to the Government constitutes an important function of the institute. Advice is given on numerous problems covering a wide field of uses of coal and other fuels.



FUEL RESEARCH INSTITUTE

JHARKHAND

Divisions

The main Divisions of the institute are:

(1) Physical and Chemical Survey of Coal Resources, including Regional Coal Survey Laboratories for Jharia, Raniganj, Bokaro-Ramgarh-Karapura, Central India, and Assam Coalfields and a Geology Section, (2) Coal Preparation, including Coal Cleaning, Briquetting, Sizing, Breakability, and Sampling, (3) Carbonization and Byproducts, including High and Low Temperature Carbonization, Blending, and Coke and Byproducts Testing, (4) Liquid Fuels, including Hydrocarbon Synthesis, Hydrogenation of Coal and Tar, Hydrocarbonization, Petroleum Substitutes, (5) Gaseous Fuels, including Fluidization, Gasification, Gas Turbines, (6) Engineering, including Combustion Engineering, Instrumentation — Drawing Office and Workshop, (7) Chemistry, including Analysis and Testing, Coal Constitution, Solvent Extraction, Benzol, Tar and Byproducts, Oxidation, Nitration, Sulphonation and Ion-exchange Compounds, Surface Properties, Rheology, Colloids and Chromatography, (8) Physics, including X-ray Studies and Spectroscopy, (9) Library and Intelligence, including Library, Statistics, Publications and Photography, and (10) Administration and Office.

Personnel

The staff of the Institute including the staff of the five Regional Coal Survey Laboratories consists of a Director, a Deputy Director, two Assistant Directors, a Chief Engineer, and 120 scientists, technologists and engineers, 125 laboratory assistants, mechanics and minor technicians, 50 office and general staff, and 300 Class IV staff.

Research Programme

The research programme is divided into a long-term programme and a short-term programme.

LONG-TERM PROGRAMME

1. Detailed physical and chemical survey of coals
2. Washability of Indian coals of all types
3. Cleaning of coals by froth flotation
4. Recovery of pyrites from coal
5. Briquetting of lignite and slack coal
6. Desulphurization of Assam coals
7. Investigations into the nature and properties of Indian coal tars
8. Recovery of cyclopentadiene, coumarone, indene, etc., from crude benzol and preparation of resins therefrom
9. Forced draught and combustion of (i) non-coking coals, (ii) coking coals, (iii) *jhama* and (iv) lignite
10. Control and efficiency of combustion plant, tempering of coals, etc.

11. The efficiency of *chulas* (domestic ovens)
12. Preparation of active carbons
13. Development and pilot plant study of ion-exchange material from coal for water softening, etc.
14. Spontaneous combustion of coal in mines and at the surface
15. Improvement and development of coal testing methods
16. Direct determination of oxygen in coal
17. Preparation of standard sand for caking index determination
19. Bomb calorimeter and its extended uses: heat balances

SHORT-TERM PROGRAMME

1. Physical and chemical survey of the chief coals of India
2. Investigations into the lignite deposits of India
3. The properties and utilization of *jhama* (burnt coal seams *in situ*)
4. Coal washing: development of plant for Indian coals
5. Briquetting of coals and lignites with and without binder
6. Carbonization, including testing of cokes, tars, gases, byproducts, etc.
7. The coking of weakly caking and semi-caking coals
8. Fluidized carbonization of coal for production of low temperature tar for hydrogenation and of char for gasification
9. Treatment of carbonaceous shales for (i) recovery of combustible matter and (ii) distillation
10. Improvements in tar oils for use as diesel fuel, fuel oil for furnace heating, etc.
11. Pyrolysis of coal tars for production of special products
12. Gasification of coal (i) with and without pressure and (ii) with and without steam or oxygen
13. Development of combustors and combustion units for gas turbines fired by powdered coal
14. Powdered fuel with different types of coal combustors
15. Synthesis of hydrocarbons by Fischer-Tropsch process
16. Hydrogenation of coal and tar
17. Hydrocarbonization of coals of different rank for production of aromatics
18. Fundamental studies in (i) coal petrography, (ii) coal constitution, (iii) surface properties and (iv) oxidation and nitration of coals
19. Solvent extraction of coal for preparing various commercial products such as colloidal fuel, road paving emulsions, electrode carbons, carbon black, coal plastics, etc.

Research Problems Completed

Some of the achievements of the institute during the past few years are given below.

COAL SURVEY

Work on the physical and chemical survey of coals was initiated in the temporary laboratory at Dhanbad in 1949. Later, five Regional Coal Survey Stations were established in the main coalfields as follows:

- (1) Jealgora, for Jharia coalfields
- (2) Raniganj, for Raniganj coalfields
- (3) Ranchi, for Bokaro-Ramgarh-Karanpura coalfields
- (4) Bilaspur, for Central Indian coalfields
- (5) Jorhat, for Assam coalfields

Preliminary Work — The basic work of a coal survey is systematic physical and chemical examination of the coal seams as they occur underground, and of the commercial grades of coal as they are marketed. Before the actual work of the survey is undertaken, existing information on the physical and chemical properties of the coal, and on the geology of the coal seams, the mining conditions, the output of the collieries, and the marketing and distribution of the coal is reviewed and collated. This information on Indian coals was collected and published in the form of a handbook (*Indian Coals: Their Nature & Composition*).

If the industries are to benefit, the test results must be correlated with the actual usage of the coal, and the coal survey laboratories provide this correlation. The coal survey organization is oriented to assist in promoting fuel economy and efficiency in industry.

Although the survey is in the early stages of organization, much has been achieved.

In the *Jharia Coalfield*, the No. 10 and No. 11 seams (which contain large coking coal reserves) are under survey and several hundred samples have already been investigated. In addition, a large number of samples from this field were analysed for industry and many samples have been investigated for detailed washability characteristics, caking index, phosphorus, sulphur, etc. — both for the survey programme and at the request of the coal producers.

In the *Raniganj Coalfield*, a survey of the Samla seam has been completed. The sampling of this seam was undertaken originally for the proposed synthetic oil plant. The survey has also provided information on the combustion characteristics of the coal and the relation of the seam to the Purushottampur seam. In addition, work was undertaken on the testing of certain coals in the Raniganj field at the request of the Committee on Conservation of Metallurgical Coal. Seam and run-of-mine samples from many collieries were examined for chemical and physical properties (especially caking index) and for ash fusion range. Carbonization assays, and in some cases washability tests, were also carried out. It was found that several of these coals were suitable for (1) direct coking, (2) mixing with low volatile coal in coking blends, (3) gas production and tar recovery at gas works and (4) low temperature carbonization. In addition, about 190 samples of coal were analysed for private parties. Many mine air analyses for control of ventilation and fires in mines have also been carried out.

In the *Bokaro Coalfield*, a survey of the Bermo seam was undertaken to assess its suitability for utilization by the Damodar Valley Corporation in their thermal power plant. The Kargali seam is now being investigated.

For the coals of *Madhya and Vindhya Pradesh*, a preliminary survey was carried out, the report has recently been published. The coals of the collieries of the *Associated Cement Co.* in Madhya Pradesh and Vindhya Pradesh were specially tested at the request of the company. In addition to normal work, detailed washability tests were undertaken, as a result of which the company proposes to erect a coal washing plant at Nowrozabad (Rewa). It was observed that, in the course of cleaning the coal, pyrites was concentrated in the washery rejects. The finding of the Survey Station was taken up at the Centre and a process for the recovery of pyrites has been developed.

A scheme for the systematic survey of the coalfields of *Hyderabad* sponsored by the Council was put into operation in July 1953 at the Central Laboratories for Scientific & Industrial Research, Hyderabad. The staff was appointed in consultation with the Director, Fuel Research Institute. The programme of work was drawn up in consultation with the Fuel Research Institute. The survey work is also to include the lignite deposits of South Arcot.

COAL UTILIZATION

1. *Types & Uses of Coal*—The preliminary data, published in *Indian Coals: Their Nature & Composition*, suggest that coals of India, considered on a unit coal basis, could be divided into three main types:

- (i) High volatile (non-coking) coals suitable for combustion, power generation and complete gasification. These coals mainly occur in the Raniganj coalfield of Bengal, in the North Karanpura field of Bihar, in the Central Indian fields, i.e. in Vindhya Pradesh and Madhya Pradesh, and in Hyderabad.
- (ii) Medium volatile (semi-coking) coals suitable for gas manufacture or blending with the coking coals as well as for combustion. These also occur partly in the Bengal and South Karanpura coalfields, and in some parts of Central India.
- (iii) Low and medium volatile (coking) coals suitable for carbonization and coke manufacture. These occur chiefly in the Jharia and Giridih coalfields, and the East and West Bokaro coalfields (both in Bihar). Some reserves have also been found in the Kanhan Valley area in Madhya Pradesh.

In addition, there are the coals of Assam, which often contain much sulphur (organic) and which are semi-coking. The deposits of lignite in Bikaner and in South Arcot, Madras, are of course non-coking but they are important local sources of fuel.

2. *Railways*—About one-third of coal produced is consumed by railways, and 90 per cent of this is used for locomotives. Rational utilization of coal by railways is, therefore, of no small importance in the overall fuel economy of the country. Of the total annual output, practically 12 million tons (out of 35 million) are of coking or (more truly) caking type, and, of this, 8 million tons are high grade. The coal consumed for carbonization, however, is only about 4 million tons. In other words, 8 million tons of caking coal (of all grades) are being consumed for power generation or for export or in locomotives, i.e. in uses other than coal carbonization.

Much work has been done in collaboration with the staff of the Central Standards Office of the Railways and the Fuels Committee of the Railways

and, some years ago, a controlled supply of preheated secondary air to locomotive furnaces was recommended.

For the railways much analytical work has also been done including complete analysis of coals, weathering and size degradation tests, spontaneous combustion tests and evaluation of clinkering properties. The work is being continued.

A scheme on a coal dust turbine locomotive furnace to be fired by powdered coal was drafted and begun at the request of the railway authorities, but had to be abandoned due to lack of funds. It is estimated that introduction of coal dust turbines on the railways would mean an annual saving of fuel amounting to several crores of rupees. The combustion part of the work may again be taken up in the near future.

3. *Beneficiation of Low Grade Coals* — Many of the coal seams in India are of inferior grade, chiefly because of high ash. Research on the cleaning of high ash coals has, therefore, been a major undertaking. Washability characteristics of several hundred Indian coals have been studied and a series of research studies has been published. Investigations have also included studies on the heavy medium process, jig washers, the cyclone process, froth flotation, controlled breakage and screening.

Coal as brought to the surface at collieries is seldom in a form or size suitable for industrial and domestic use. Only in a few cases is the practice of grading coal by screening into several sizes followed. Most collieries remove larger pieces of shale and stone by hand-picking. As the better seams of low ash coal become depleted, seams which do not readily provide clean coal have to be exploited. Extension of coal winning by machine mining is also on the increase, and, as such mining tends to produce a dirtier coal, the need for developing and applying satisfactory and economical coal cleaning methods is now being felt. Much of the coal output of India is confined to the eastern region, 80 per cent coming from the Bengal and Bihar fields. As it is uneconomical to haul low grade coal over long distances, coal cleaning becomes all the more important. Further, with the exclusion of China from the international market, and with the growing demands for coal in U.K., Japan and America, the export market for Indian coal is expanding. Consumers at a distance are averse to paying large freight charges for carrying incombustible matter with the coal, and a consistent quality is desired by practically all industrial users. Consequently, coal preparation, screening and washing, requires serious attention, and this work has been given priority.

The Indian coal industry as a whole has not yet made full use of the institute's investigations into coal cleaning and washing, with the exception of the *Tata Iron & Steel Co. Ltd.*, who are responsible for the installation of two large-scale coal washeries in Bihar. It is, however, likely that other firms will install coal washeries of various types and sizes in the near future. Washability investigations have been carried out for several firms and collieries, including *Bird & Co.*, the *Damodar Valley Corporation*, the *Indian Iron & Steel Co.*, the *Lodna Coal Co.*, *MacNeil Barry & Co.*, the *Singareni Collieries Ltd.*, the *Associated Cement Co. Ltd.*, and many others. The establishment of a washery by the railways is contemplated, and numerous coals are now being investigated.

4. *Power Generation & Utilization of Low Grade Coal* — For fuel for the Bokaro Thermal Power Station (20,000 kW.) of the *Damodar Valley Corporation*, the Fuel Research Institute was consulted. This power station, the largest of its kind in India, will consume about 2,000 tons of coal per day. It has been shown that the cheap low grade high ash coal of the

Bermo seam may be used as pulverized fuel, even if a proportion of the coal is first recovered for coking.

For large-scale undertakings of this kind, careful sampling and detailed work are necessary. Many properties of the coal have to be evaluated such as run-of-mine size analysis, breakability, de-watering and drying, grindability, proximate and ultimate composition, phosphorus, chlorine and sulphur content, composition and fusion range of ash, washability of the coal in different sizes, composition of washed fractions, coking characteristics and blendability of washed fractions, heat generation capacity, reactivity, etc. In addition, a physical and chemical survey of the seam and of the borehole samples has to be carried out. A report on the *Utilization Survey of the Bermo Seam* has been published jointly with the Damodar Valley Corporation. The use of lignite for power generation is discussed in item (10) below.

5. *Briquetting* — A large part of the coal produced in India is slack coal, i.e. less than one inch in size. The slack produced from coking coals can often be sold for coke making, but there is practically no such market for the slack produced from non-coking coals. Briquetting of the slack coal for domestic or commercial use, however, offers an outlet.

Briquetting tests have been carried out for some time on slacks from non-coking coal from the Raniganj coalfield. Preliminary tests on Jammu coals have shown that this coal also can be briquetted.

6. *Special Coke for Carbide Manufacture* — Work was undertaken at the request of a commercial firm (desiring to manufacture calcium carbide) to produce a low ash and low phosphorus coke. The adoption of suitable size selection and washing technique, including froth flotation, led to the production (from Giridih coal) of a coke with 6-8 per cent of ash and 0.002 per cent of phosphorus. Further work on the production of low ash coke for manufacture of electrodes is also on hand.

7. *Soft Coke for Domestic Use* — By low temperature carbonization of Indian coals, valuable tar and soft coke (for domestic fuel) have been obtained. The development of a proper L.T.C. industry will remove much of the smoke nuisance and atmospheric pollution in big cities and in coalfields, and lead to cleaner and better homes for the masses. Steps have been taken to install a suitable plant (narrow brick retorts) at the FRI.

8. *Spontaneous Ignition & Storage of Coals* — Large quantities of coal are destroyed or "sealed off" through fires resulting from "self-heating" of coal in the mines and in bulk storage at depots and works and in ship bunkers. The mechanism of self-heating from oxidation is being studied, and investigations into methods of storage to reduce the risk of fires (above and below ground) are being made in co-operation with industry. The problem is serious in the mines of the Central Indian and the Bihar and Bengal coalfields. To detect coal heating in its early stages in the mine, accurate and special analyses of mine air are invaluable. The institute is continually engaged in such work.

9. *Breakage of Coal & Size Analysis* — Since breakage occurs unavoidably during mining and the coal produced covers a range of different sizes, size analysis of coal is of importance, e.g. to assess the quantity of different sizes that can be readily and economically obtained from different coals. With the knowledge thus gained, one can design or adopt combustion appliances to operate efficiently and easily on the fuel sizes and types available, and thus improve the general economy of coal consuming and coal producing industries. A knowledge of the natural size groups of

coal is useful also in the selection and design of coal washing plant. The relative resistance of different coals to breakage is also of importance in the utilization of coal as pulverized fuel. Accordingly a survey of the size distribution of Indian coals has been undertaken. The work on "Breakability" has led to the determination of a "Toughness Factor", obtained by correlating the average particle size of broken coal (in various grain sizes) with percentage weight of the broken products under standard conditions. The "Toughness Factor" can be calculated from the screen analysis of the broken product resulting from standard shatter tests. Six technical papers have been published by the institute on the subject.

10. *Lignite Investigations* — Much advisory and testing work has been done (at the request of the Government of Madras) on South Arcot lignite. Samples have been analysed and tested, and the Montan wax content determined with a view to possible extraction and utilization. Further work is on hand on combustion, low temperature carbonization, briquetting, gasification and drying of the lignite. It has been shown that the lignite of South Arcot ($2,000 \times 16^6$ tons are said to be available) is similar in composition to the Australian and German brown coals. If the deposit is exploited successfully, a large thermal generating plant could be set up; some of the lignite may also be briquetted and some may be carbonized. The industrialization of the area will be much accelerated, and South India will have its own much needed source of solid fuel, as brown coal.

CARBONIZATION & BLENDING OF COAL FOR COKING

The possibility of shortage of coal suitable for metallurgical coke manufacture has perturbed the Indian iron and steel industry for some years. Recent research has now allayed much of this fear. In 1950 the Government of India set up a Committee on the Conservation of Metallurgical Coal to review, among other things, "the publications and recommendations of the Fuel Research Committee, FRI, and other research bodies", and to consider "what results can be achieved by the blending and washing of coal". It is now generally agreed that, if the findings of these researches (including those of the Coal Blending & Coking Research Subcommittee) are utilized, the life of India's coking coal reserves can be roughly doubled. Further work into coal carbonization problems is in progress.

The potentialities of the Central Indian coals for the projected Government iron and steel plant have been explored with the co-operation of the Coal Blending & Coking Research Subcommittee, and a report (*Preliminary Survey of M.P. Coals*, 1952) has been published. The survey has shown that certain M.P. coals can be utilized in blends of 20-50 per cent with high grade Jharia or Bokaro coking coals for manufacture of metallurgical coke.

A survey of coke oven operating conditions at the existing plant and the correlation of these conditions with the tar yields from the coals have been carried out. Much testing work has been done (1) for the new Simon-Carves Coke Oven Battery erected in 1950-51 at the Kirapur works of *Indian Iron & Steel Co.*, and (2) in the utilization of coke breeze (fines) for the Bhowra Coke Plant. A study of the oven operating conditions of the Government Coke Oven Plant at Giridih has also been made.

particularly suitable for hydrogenation to liquid fuel and the presence of sulphur is no disadvantage. Indeed the utilization of the researches already carried out could lead to the development of a useful chemical industry based on Assam coal and its hydrogenation.

(g) PYRITES FROM COAL — In connection with the washability investigation on a Rewa coal, it was observed that roughly 1.6 tons of pyrites per 100 tons of coal could be obtained in the rejects and concentration of the pyrites was feasible by "tabling" such rejects. The pyrites recovered had roughly 42 per cent sulphur with less than 9 per cent of carbon, which is within the normal specification for pyrites for the manufacture of sulphuric acid. About 25 per cent of the original pyrites present in the coal remained in the clean coal. Of the pyrites present in the rejects, about 62 per cent could be recovered by first crushing the rejects and then "tabling". The total pyrites recovered from the coal was thus of the order of 52 per cent of the amount present in the raw coal. On the basis of 150 tons per hour coal washing plant, about 50 tons of iron pyrites (equivalent to about 25 tons of sulphur) per day could thus be obtained. The *Associated Cement Co.* of Bombay are pursuing the matter with the object of installing a coal washery with pyrites recovery plant.

STANDARDIZATION — SAMPLING, TESTING & ANALYSIS

The recognition of the necessity of standardization as an efficient aid in industrial production and consumption of coal is acknowledged. In formulating standards for coal and coke special difficulties have to be faced owing to the diversity of methods of mining and of coal characteristics at the points of loading and of consumption. Production and consumption techniques have to be integrated and sampling is all important. In co-operation with the Sectional Committees of the Indian Standards Institution, Fuel Research Institute plays an important role in advising upon standard specifications for sampling, size grading, and for the analysis and testing of coal and coke.

In sampling and sizing, the institute has often taken the initiative in making new suggestions, while in the field of analysis and testing the institute has made significant contributions in the shape of new methods for determination of nitrogen, phosphorus, volatile matter, calorific value, ash and moisture. Some of the "standards" proposed have been approved by the International Standards Office and others are under consideration. This work which has been conducted in close co-operation with the Indian Standards Institution is of great value, nationally and internationally.

Problems on Hand

The following is a general statement of the problems and researches on hand:

1. Geology and petrology of coal
2. Lignite investigations
3. Experiments on coal sampling
4. Screening of run-of-mine coal and friability tests on coal samples
5. Study of size and shape of coal

6. Study of particle size distribution in smoke and dust clouds
7. Washability of coals and coal washing plant
8. Carbonization: high and low temperature
9. Coal tar investigations
10. Fluidization studies
11. Water gas shift reaction
12. Combustion engineering, heat balances, coal tempering, etc.
13. Synthesis of hydrocarbons by the Fischer-Tropsch process
14. Combustion of powdered fuels
15. Hydrogenation of coal and of coal tars
16. Preparation of active carbon from coals and lignites
17. "Ashless carbon"
18. Ion-exchange compounds
19. Desiccants from coal
20. Sulphuric acid from sulphur coals
21. Direct determination of oxygen in coal
22. Determination of British Swelling Index of coals using an electric cone heater
23. Analysis of water, mine air, etc.
24. Preparation of standard sand from indigenous sources for determination of caking index of coal
25. Absorption spectra of coal tar products
26. Electrical conductivity of coke and heat of wetting
27. X-ray study of washability of fractions of Nowrozabad coal
28. Structure of coal in relation to graphite
29. Analytical and testing methods

Fundamental Research

Most of the work has been on industrial problems but fundamental work has been conducted simultaneously and has often aided in the better understanding and in the solution of the industrial problems themselves. The following are some of the schemes covering fundamental scientific work:

1. Moisture in coal
2. Heat of wetting
3. Oxidation of coal and spontaneous combustion
4. Coal constitution
5. Solvent extraction of coal
6. Coal tar composition and products

Aid to Industry

Technical aid to the industry and to the Government constitutes an important function of FRI. Assistance is given on numerous problems covering a wide field of uses of coal and other fuels. The field of consultations

has covered: washability of coals, installation of washeries, coal and coke for iron and steel industry, pulverized fuels, manufacture of electrode carbons, coking properties of coals, locomotive fuels, coal dust explosions, spontaneous combustion, soft coke manufacture, mine air and mine water analyses and treatment. In addition, analyses of coal, coke, etc., are also undertaken for collieries, industries, railways and firms requiring tests on coal, coke and other samples, yielded an income of more than Rs. 1,00,000 during 1951 and 1952.

It will be seen that the field of consultative work is large. With the formation of the Coal Board and the adoption of a national approach towards the problems of production and utilization of coal, the advice and services of the FRI will be utilized more and more.

CENTRAL GLASS & CERAMIC RESEARCH INSTITUTE CALCUTTA

THE need for the establishment of this institute was first considered in 1942 and, after some meetings, the committee, which was appointed to examine the question, recommended the establishment of this institute at Calcutta. The recommendation was accepted by the Governing Body of the Council in 1944. The foundation-stone of the institute was laid on 24 Dec. 1945 by Sir Ardeshir Dalal, who was then the President of the Council of Scientific & Industrial Research. The construction of the main building was started in 1948 and the institute was opened on 26 Aug. 1950 by Dr. B. C. Roy.

Donations

The institute has received the following donations towards its capital funds:

<i>Donor</i>	<i>Amount</i> Rs.
The late Dr. U. N. Brahmachari	10,000
Bengal Glass Manufacturers' Ass.	10,000
The late Mr. I. D. Varshni	10,000
All-India Glass Manufacturers' Ass.	30,000*
Prof. W. E. S. Turner	250
Mr. Ram Kumar Agarwala	2,00,000†

Scope & Functions

The subjects of study at the institute are: glass, refractories, pottery, and enamel. The following are among the main functions of the institute:

1. Fundamental research concerning the different branches of glass and ceramics

*Part received. †Mica research.



CENTRAL GLASS & CERAMIC RESEARCH INSTITUTE
CALCUTTA

2. Testing and standardization
3. Technical assistance to industry
4. Dissemination of technical information
5. Training of glass technologists

Personnel

The staff consists of a Director, 2 Assistant Directors, 3 Senior Scientific Officers, 6 Junior Scientific Officers and an Administrative Officer besides others.

Programme of Research

The present programme of work can be broadly classified as follows:

1. Study of methods for improving the quality of glass and ceramic products produced in the country with special reference to raw materials, standardization, examination of defects in the articles produced, methods for removing such defects, and simple methods for testing which can be adopted in works practice.
2. Finding out substitutes for raw materials scarce in the country or whose supplies may be cut off during any emergency and utilization of naturally occurring materials in the country.
3. Investigations on the possibility of producing articles so far imported and developing new products of special use in the country.
4. Technical assistance to industry.
5. Fundamental research.

Research Problems Completed & Problems on Hand

Detailed surveys of raw materials for the glass and ceramics industry were undertaken. Results of investigations on availability and beneficiation of sands, sandstones, etc., required in glass manufacture have been published and it has been shown that India has abundant supplies of these raw materials of good quality almost in every State. Processes for improving the quality of poorer grades of sand have been worked out and a number of units such as sand washing plants, magnetic separators, vibrating tables, etc., have been installed. Facilities have been extended to industry for trials on their raw materials.

More than 800 samples of clays from different parts of India have been examined and about 80 samples taken up for detailed investigations. A monograph on the results of the work done so far is under preparation. An investigation of different types of clays available in the country has been undertaken in collaboration with the Geological Survey of India, the States and the Indian Bureau of Mines who collect the samples and send them to the institute for examination. Results of similar investigations on properties of Indian talcs have already been published. The quality of some of the talcs is very good and apart from their use in the Indian industry, which is under investigation, they may find a good export market.

STANDARDIZATION

For investigating defects in raw materials and finished goods and to help the industry in producing quality goods, the institute is actively engaged in collaborating with the Indian Standards Institution. Specifications for glass ampoules, vaccine phials and glass sands have been finalized keeping in view the present needs of Indian industry and are shortly to be issued by the Indian Standards Institution. The work of drawing up standards for limestone and dolomites for glass making and clays for ceramic industries is in progress. An appreciable amount of work on properties of Indian raw materials and methods of testing has been done to facilitate drawing up of their specifications.

GLASS CONTAINERS

One of the biggest items of production of glassware in India is bottles and other containers which are mainly consumed in chemical, pharmaceutical, toilet, ink and other allied industries, constituting 40 per cent out of a total average tonnage of about 1,00,000 tons per annum. Complaints from chemical and pharmaceutical manufacturers about the suitability of Indian bottles in several cases alleged that due to poor quality of bottles, the chemicals deteriorated and were even rendered unsuitable. Investigations on the subject were organized in co-operation with both glass producers and the consuming industries. It is expected that very soon the difficulties of glass producers will be overcome and products of good quality will be made available.

1. *Ink Bottles* — An investigation of ink bottles showed that the bottles were responsible for deterioration of the ink in some cases. Suitable glass compositions for making ink bottles were worked out and a test for judging the suitability of such bottles was suggested. The results have been published and a discussion organized to bring them to the notice of the industry.

2. *Distilled Water Bottles* — Work on glass compositions for bottles for containing distilled water extensively used in pharmaceutical industries has also been completed.

3. *Soda Water Bottles* — Consumers and manufacturers of soda water bottles were brought together and their problems analysed. The bottles are now being produced in the country and the institute is trying to lay down standards for them.

BETTER CLASS SAGGARS

Saggars required in pottery works for placing the articles in kilns during firing are used over and over again but break after some firings. The life of saggars obviously affects the overall cost of production of pottery ware. The life of saggars normally used in Indian factories is low, usually about five to six firings. Detailed investigations have been carried out and several tons of successful compositions made from raw materials available in the country have been distributed to various factories for conducting trials under their own conditions of manufacture and firing. So far the life of these saggars has been reported by some factories to go up to 18 cycles, several still continuing in service. Saggars

made according to these compositions may be effective in reducing the cost of production to an appreciable extent.

SAND-LIME BRICKS

In order to utilize the waste lime sludge accumulating in acetylene gas making, the institute investigated possibilities of sand-lime bricks. Compositions of sand-lime bricks incorporating lime sludge were pressed into shape under different pressures and treated in an autoclave under different pressures for varying periods. To produce bricks of different colours, the effect of adding organic and inorganic colourants was also studied and good sand-lime bricks, with strength in some cases even superior to that obtained by using ordinary lime, were produced. The results have been published.

SUBSTITUTES FOR SCARCE RAW MATERIALS

1. *Boron-free Enamels* — One of the essential chemicals required in the manufacture of vitreous enamel ware is borax which is mainly imported. Experiments were conducted successfully for producing enamels without borax from raw materials available in the country. Factory trials on the new compositions have shown them to be comparable in performance to borax enamels.

2. *Salt Cake* — It has been shown that naturally occurring Didwana salt cake could be utilized for substituting soda ash to an appreciable extent in making amber glassware. In addition, this partial substitution also eliminates the use of sulphur. The utilization of this material for sodium silicate and other industries is under investigation.

3. *Utilization of Waste Mica* — Vermiculite bricks are fairly extensively employed as backing on furnaces for insulating purposes. Only one firm in India seems to be now manufacturing these bricks from vermiculite stated to be imported from South Africa.

Experiments initiated to examine if waste mica could be utilized for making such products have shown that it is possible to make insulation bricks with waste mica comparable in performance to vermiculite bricks. Large-scale tests will soon be undertaken.

4. *Glass Bangles* — Following investigations on production of signal glasses, investigations to substitute indigenous materials for making red bangles produced by the biggest cottage industry at Firozabad were undertaken. The samples produced are now under examination.

INVESTIGATIONS ON PRODUCTION OF ARTICLES SO FAR IMPORTED

1. *Chemical Porcelain* — Laboratory porcelain (known as chemical porcelain) articles are extensively employed in scientific and technical institutions and are imported. The imports have become restricted and educational institutions have been seriously handicapped. The institute has conducted investigations on the possibility of manufacturing chemical porcelain ware in the country. Samples of articles such as dishes, crucibles, basins, etc., produced in the laboratory have been tested in some of the leading chemical laboratories and found to be comparable

in performance to imported articles. It is hoped that their production in the country will soon be initiated.

2. *Ceramic Enamelled Wire-wound Resistors* — A large number of imported enamel-coated resistors are used in electrical installations and in radio communications. Investigations were undertaken for the production of some low and high ohmic value resistors. Enamel compositions meeting the necessary specifications have been successfully made and have given satisfactory performance test.

3. *Ceramic Colours* — A variety of ceramic colours used in the pottery industry for decorating purposes were prepared in the laboratory in fairly large quantities and in several batches. Their performance has been tested by the factories under manufacturing conditions, and they have been found to match well in quality and performance with imported colours. The question of organizing their production in the country is now under consideration.

4. *Signal Glasses for Railways & Traffic Installations* — Signal glasses used for signals in various shapes and sizes are an essential requirement of railways and other traffic installations. The possibility of making them in the country was examined and the samples produced have been tested side by side with the imported ones by railway authorities. Hundreds of samples of the standards selected have been produced and distributed to the railways all over the country. Reports of their successful performance under operating conditions from several of them have already been received. The question of producing them in the country is now under active consideration.

5. *Automobile Spark Plugs* — Spark plugs used in automobiles are imported to the tune of rupees 15-20 lakhs per annum. Investigations on the possibility of their manufacture in the country were undertaken and experimental spark plugs produced have given satisfactory performance in the laboratory. Production of about a thousand spark plugs, for trials to be conducted by motor works and dealers, is in progress.

6. *Dental Porcelain* — Artificial teeth made of porcelain are now extensively utilized and are entirely imported. The institute has recently taken up investigations to examine the possibility of their production in the country as all the raw materials are available. Some samples have already been produced and are under examination.

7. *Foam Glass* — Foam glass, a special type of glass, light in weight with a multicellular structure, is an excellent thermal insulating material, and can replace cork in several applications. It has the advantage of being non-combustible and unaffected by moisture. In a tropical country like India such a material, if produced on a large scale, will have wide use in housing and refrigeration industries. This novel material is stated to be now fairly extensively employed in the U.S.A. and Russia, but the methods of its production are covered by patents and are closely guarded secrets. As a result of systematic investigations, the institute has been able to work out methods for its successful production. Samples prepared are comparable in performance to the imported product. A pilot plant is being set up.

Technical Assistance to Industry

The institute has assisted firms, Government departments, educational and scientific institutions by processing and examining materials, investi-

gation of special problems, making and supplying special articles in some cases, visits by technical staff to plants in operational or production difficulties and supplying information on topics of technical interest. A small Refractories Section for fabricating special refractory parts, which in view of their small demand or special characteristics are not usually made by firms in India, has been organized. These facilities have been extended to several scientific organizations and private firms and has helped them considerably in avoiding delays due to import difficulties. Altogether assistance has been rendered to about 800 parties during the last three years.

Future Plans

1. *Five-year Mineral Development Programme* — One of the duties assigned to the institute under the Five-Year Plan is connected with investigations on the utilization of mineral resources of India. The institute had already been conducting investigations on the availability and beneficiation of raw materials but now this programme has been given special importance. Under this category the programme for the next year will cover investigations on chrome-magnesite refractories, glass house refractories and also for providing refractories particularly to the glass industry in which the supply of proper refractories is very essential for quality production.

2. *Optical Glass* — Optical glass, one of the essential materials for the fabrication of lenses and mirrors for a wide variety of instruments such as microscopes, cameras, telescopes, etc., is considered a key and strategic material. All the requirements of the country are imported. Its production is confined to a few countries and in view of its importance in defence matters, the processes are closely guarded secrets. The institute has already examined the resources available in the country, and has shown that raw materials suitable for making optical glasses are available in the country. The director of the institute spent about four months in an American Government plant learning the technique of production in 1948 and as a result of further negotiations two senior scientific officers of the institute have been deputed to work in this plant under the Point Four Programme. It is hoped that by utilizing this knowledge and experience, it will be possible to produce this much-needed material for making the defence services independent of imports and helping the establishment of an optical instruments industry in the country.

3. *Sun Glare Glasses* — Along with the above, the possibility of producing sun glare glasses extensively imported into the country will also be examined.

The institute is shortly undertaking publication of a bulletin giving information on different aspects of the industry both in India as well as abroad. The institute is a member of the International Commission of Glass. The director of the institute was elected to the Commission in 1948 to represent India.

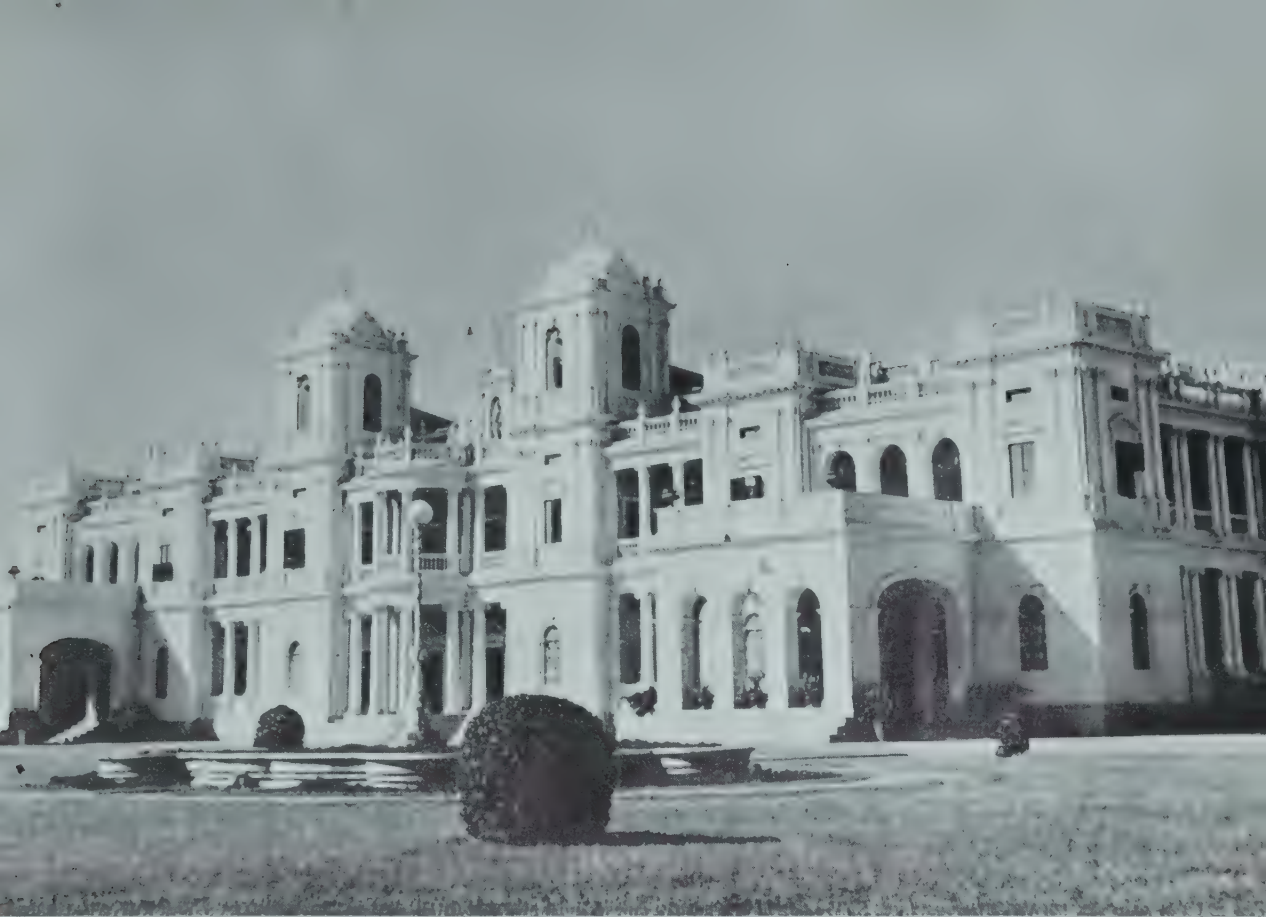
CENTRAL FOOD TECHNOLOGICAL RESEARCH INSTITUTE MYSORE

Introduction

THE Industrial Research Planning Committee suggested the establishment of a Central Food Technological Research Institute. In February 1948, the Council accepted the proposal. The Government of Mysore made a generous offer to place the "Cheluvamba Mansion" in Mysore together with the attached buildings, gardens, parks and ground (covering about 150 acres) at the disposal of the Council for the location of the institute. The Institute of Fruit Technology, which was temporarily shifted to Delhi after partition, was amalgamated with the institute with the concurrence of the Ministry of Agriculture. The institute was declared open by Shri C. Rajagopalachari on 21 February 1950.

Scope & Functions

The institute deals with all aspects of food technology aimed at a better conservation and more efficient utilization of food material available in the country. Its functions include: (1) storage and preservation of different classes of food materials; prevention of spoilage; reclamation and utilization of partially affected materials; (2) processing of foodstuffs to improve their keeping quality and facilitate ready usage; refrigeration, freezing, gas storage, dehydration, canning, etc.; (3) treatment of different coarse food materials to improve their palatability, digestibility and general food value; elimination of harmful and unpalatable ingredients; (4) study of new and hitherto unfamiliar sources of food materials; their processing and fortification to render them more wholesome and acceptable; emergency food; (5) preparation of concentrated foods, vitamins and other food accessories, composite and multipurpose foods, ready-to-serve foods, supplementary foods, food substitutes, etc.; (6) preservation of fruits, vegetables and other perishable articles; training of personnel into methods of preparation of squashes, jams, preserves, pickles, chutneys, etc., and general investigations into fruit technological problems including possible use of exhaled gases, artificial colourization and antioxidants for preservation of shape and food quality; (7) dietetics, design and demonstration of improved types of food preparations to suit economic conditions and tastes of people in different regions; improved cooking methods; (8) study of problems of food industries; provision of technological information; survey of existing industries, their technical problems and collection of factual data for development of new industries; pilot plant trials with different types of industrial equipment; (9) food sanitation; survey and advice on hygienic conditions in food industries; treatment and utilization of waste products from food industries; (10) development of improved and rapid methods of determining quality of food products, detection of new and unfamiliar adulterants, and (11) food information; dissemination of general information bearing on food and dietary problems; popular presentation of important developments in food technology, issue of bulletins and charts for the preparation of home preserves, different small-scale industries; demonstration of new methods.



CENTRAL FOOD TECHNOLOGICAL RESEARCH INSTITUTE
MYSORE

Divisions

The scientific work of the institute is carried out in divisions and sections dealing with (1) Food Storage and Preservation, (2) Fruit Technology, (3) Food Processing, (4) Food Engineering, (5) Biochemistry and Nutrition, (6) Food Information and Statistics, (7) Quality Control, and (8) Microbiology and Sanitation.

Personnel

The staff of the institute consists of a Director, an Assistant Director, 10 Senior Scientific Officers, 12 Junior Scientific Officers and an Administrative Officer besides others.

Research Programme

The institute has evolved a number of food products and processes, brief descriptions of which are given below.

1. *Vegetable Milk* — A good fortified vegetable milk, as nutritious as cow's or buffalo's milk and yielding palatable curds and butter-milk, has been prepared from groundnuts. Eight lb. of milk can be obtained from a pound of groundnuts. The process has been successfully worked out on a pilot plant scale and covered by a patent and has recently been released for commercial development to a well-known firm in South India. Arrangements are also under way for leasing the process to interested parties elsewhere.

2. *Malted Milk Powder* — A method has been standardized for the preparation of malted milk powder by making use of malt extract from ragi (*Eleusine coracana* Gaertn.) and milk. Two types of infant foods, with and without cocoa, have been prepared and found to be nutritious.

3. *Agave Syrup* — Experiments on *Agave vera-cruz*, which grows under semi-arid conditions and is commonly used for fencing, revealed that the tuberous portion of the stem of the plant is rich in polyfructosans. The polyfructosans have been converted by simple hydrolysis to fructose syrup, a very sweet and non-crystallizable syrup that may be of special interest to the confectionery industry. This process has been patented.

4. *Banana Starch* — A method has been developed for the economic preparation of edible and industrial starch from the banana stems. Each stem yields 1½ to 3 lb. of starch depending on its size. A pilot plant has been set up for its production.

5. *Composite Protein Food* — Using casein as the base, a composite protein food has been prepared, fortified with B vitamins and essential minerals. The process is covered by a patent.

6. *Tonic Food* — A highly nutritious protein food in the form of *grains*, *rods* and *flour* has been prepared. It contains 25 per cent proteins and a fully balanced complement of carbohydrates, minerals, vitamins, fats, etc. Trials on hospital patients have shown that the food is useful in wasting diseases and during convalescence.

7. *Diastase* — A process has been evolved for producing fungal diastase using wheat bran as the raw material. Conditions have been standardized for purifying the diastase to conform to the standard requirements of pharmaceutical industries.

8. *Mysore Flour*—A cheap and nutritive product, called "Mysore Flour", which does not require much processing, has been evolved from tapioca and groundnut cake flours. It provides over 12 per cent protein besides a complement of necessary vitamins and minerals. Prepared in the form of gruel and *mulhe* it was fed daily to 5,800 people in some of the gruel centres in Madras and Mysore States and proved to be a valuable "famine food".

9. *Synthetic Grains*—Investigations showed that rice and other food-grains in our diet can be replaced, up to 25 per cent, by sweet potato or tapioca flour without affecting the overall nutritive value of the diet. This finding led to the development of synthetic grains, which were made from 85 parts of tapioca flour and 15 parts of groundnut cake flour. The grains were given the shape of rice so that it will have an appeal to the rice-eating people. The experiments carried out early this year in the U.K. and Switzerland by the director of the institute showed that rice-shaped grains can be made on a large scale by means of batch type automatic machinery from the dough of the composition evolved at the CFTRI. Incorporation of a certain percentage of cereal components (such as corn starch and/or wheat flour) further improved the cooking qualities of the product.

10. *Ginger Cocktail*—A process for preparing a non-alcoholic fruit beverage called "Ginger Cocktail" which can be served both as a plain beverage and as a carbonated drink has been developed. Arrangements are being made for leasing out the process for commercial exploitation.

11. *Vinegar*—An inexpensive cottage-scale vinegar generator which can produce about 16 bottles of good quality vinegar per day has been devised.

12. *Tonic & Medicated Wines*—Tonic and medicated wines, using Indian fruits and medicinal herbs, have been formulated to supply the minimum daily requirements of the body in respect of accessory food factors and minerals.

13. *Pectinase & Pectin*—A method has been worked out for preparing fungal pectinase from *Penicillium notatum* for clarifying fruit juices. Pectin for preparation of jellies has been prepared from jack fruit waste, papayas, wood-apples and guavas.

14. *Orange Juice Powder & Concentrate*—Special methods for preparing orange juice concentrate and powder have been evolved. The concentrate and the powder on reconstitution have all the desirable properties of the original fresh juice. Similar fruit juice powders have been prepared from mangoes, papayas, pine-apples, guavas and grapes, and concentrates from guavas, pine-apples and grapes. The process has been patented.

15. *Cashew-apple Products*—Cashew-apple, large quantities of which go to waste every year, has been utilized for making juice, squash, jam, candy and pickle. Cashew-apple candy is as attractive as fig candy.

16. *Bamboo Products*—Several products like pickles, chutneys, preserves, curried vegetable, canned shoots in syrup and in brine, candy, etc., have been prepared from tender bamboo shoots, after eliminating their harmful ingredients.

17. *Passion Fruit Squash*—A palatable beverage with a pleasing and delicate aroma has been prepared from Passion Fruit (*Passiflora edulis* Sims.) which grows wild in the Nilgiris and Coorg. A carbonated beverage called "Passionpop" and a cordial have also been prepared.

18. *Amla Bars*—Fruit bars from Amla (*Phyllanthus emblica*), which is 20 times richer in vitamin C than oranges, have been prepared.

19. *Canned Jack Fruit Bulbs*—Ripe jack fruits which have so far not been industrially utilized have been successfully canned. A good squash called “Jack Nectar” and slabs of attractive colour and flavour, besides toffees, have been prepared from the ripe bulbs. The method of preparing jack fruit slabs has been patented. The jack fruit rind has been used for preparing a thick syrup.

20. *Vanilla Essence*—Vanilla beans grown in India have been found suitable for making vanilla essence of good quality.

21. *Banana Products*—Methods have been standardized for preparation of several attractive products like chips, toffee (plastic and non-plastic types) and figs glaze from bananas.

Industrial Research Problems

Research projects and processes of industrial importance standardized include the following:

1. *Impregnation of Jute Bags for Grain Storage*—A method has been evolved to impregnate jute bags with insecticides like pyrethrum, lindane and piperonyl butoxide for effective storage of grain. The grain stored in these bags is not affected by the impregnating chemical. The method is now being tried on a semi-large scale in Government godowns.

2. *Alcohol Extraction of Edible Oils*—A process has been developed for better extraction of edible oils from oilseeds like groundnut and cotton seed, using alcohol as solvent instead of hexane and other hydrocarbons. By this process it is also possible to obtain edible oilseed flours. The process has been patented.

3. *Storage of Cashew Kernels*—A method has been evolved for preserving cashew kernels by roasting them in hydrogenated groundnut oil stabilized with antioxidants. The kernels when packed in sealed tins keep well for 9 months at ordinary temperatures.

4. *Cold Storage*—Optimum conditions of temperature and relative humidity for storage of potatoes, mangoes, oranges, limes, jack fruits, brinjals, cabbages, cauliflowers, beet roots, knol-khols and eggs have been determined. The data have been made available to the cold storage units in the country.

5. *Deep Freezing*—Methods have been developed for successfully preserving ripe mangoes, mango slices, pine-apples and lichis for one year by deep freezing.

6. *Parboiling of Rice*—A new method of parboiling rice has been worked out to prevent off-flavour development and other undesirable features associated with some commercial samples of parboiled rice.

7. *Instant Rice*—A process for preparing “Instant Rice” has been completed. Cooked rice can be obtained in less than 3 minutes by adding one part of Instant Rice to 3 parts of boiling water.

8. *Coffee Research Project*—Work in progress under a three-year scheme sponsored by the Indian Coffee Board has shown that coffee flavour is best preserved by preparing coffee brew in glass and stainless steel filters. Brass filters, if used, must be tinned to conserve most of the natural flavour and aroma of coffee.

A “wetting technique” of coffee powder has been developed to get more cups of good quality from a given amount of powder.

Other lines of work in progress include use of coffee husk in place of chicory, development of quicker techniques of processing parchment

coffee, detection of adulteration and preparation of soluble coffee and coffee tablets.

9. "*Besan*" *Sweets* — Work on the canning and shelf-life of Indian sweets is in progress. The shelf-life of canned *besan* sweets and *burfi* has been extended up to eight months by the addition of BHA and gallates (propyl and dodecyl gallates) respectively.

10. *Little-known Foods* — It has been found that the seeds of *Amaranthus paniculatus* or "*Rajgira*" are rich in protein of high biological value and are about thrice as nutritious as rice. The puffed grains of this plant can serve as a cheap and nutritious breakfast food.

The nuts of *Terminalia bellerica* have been found to be a rich source of fat and proteins. The nut is edible and the determination of its fatty acid composition is in progress.

11. *Salt in Human Nutrition* — A stratified single stage random sample survey was carried out in Mysore City in 1,694 families representing 12,186 persons for estimating the per capita daily consumption of salt and other articles of food in the diet. It was found that the per capita consumption of salt was 19.2 g. per day, and that the ratio of salt to cereal consumption was 1:19.3. Investigations on the quality of common salt and nutritional studies with reference to mineral impurities, particularly calcium and magnesium, are in progress.

12. *Fruit Products Order* — A Fruit Products Order Testing Unit of the Government of India has been located at the institute where Indian and foreign fruit products are analysed.

13. *Fruit Technology Diploma Course* — The institute conducts a Post-graduate Diploma Course where students from different States and candidates sponsored by factories are given an intensive theoretical and practical training in fruit and vegetable preservation.

14. *Training in French & German* — Elementary and advanced classes in French and German are conducted for workers.

Aid to Industry

The institute supplies advice and information in reply to technical enquiries received from food industries and interested parties. It maintains a close liaison with food industries through its monthly bulletin, *Bulletin of the Central Food Technological Research Institute, Mysore*, and also by personal visits to factories, wherever necessary. Symposia are arranged to bring representatives of industries and the Government and scientists together to discuss problems of interest to food industries. Short or long-term *ad hoc* problems are taken up for study at the instance of the industry. Among these may be mentioned the following:

1. *Modified Shortening* — A modified vegetable shortening, melting at 41°-42° C., which is expected to give a better shelf-life to Indian biscuits, has been evolved. The digestibility and nutritive values of the biscuits are not affected as a result of the higher melting point of the shortening. The Government of India have recently permitted the manufacture of such shortening for use by the biscuit industry.

2. *Rolled Oats & Corn Flakes* — Improvements have been effected in the processing and packaging of rolled oats and corn flakes.

3. *Tapioca Starch & Sago* — The institute has designed and set up a production unit for a tapioca sago manufacturing concern in South India.

CENTRAL DRUG RESEARCH INSTITUTE, LUCKNOW**Introduction**

THE Drugs Subcommittee of the Board of Scientific & Industrial Research recommended the early establishment of a Central Institute for Drug Research. The scheme for such an institute was adopted by the Council in August 1947. The Planning Committee after a careful scrutiny came to the conclusion that the location of the Central Drug Research Institute would be advantageous at Lucknow from several aspects and recommended that the generous offer of the Government of Uttar Pradesh placing the historic Chattar Manzil Palace at the disposal of the Council for housing the institute should be accepted. The Central Drug Research Institute was opened by the Prime Minister, Shri Jawaharlal Nehru, in February 1951.

Scope & Functions

The essential functions of the institute are: (1) promoting drug research in general; (2) testing and standardizing drugs discovered in the institute and providing expert advice for the further development and production of these drugs; (3) offering facilities and advice to scientists, universities, other interested institutions, industries and individuals who may not be in a position to carry out or complete investigations on matters relating to drugs; (4) organizing controlled clinical trials of drugs in hospitals and clinics; and (5) disseminating scientific knowledge relating to drugs.

Divisions

The work of the institute is divided under seven Divisions: (1) Botany and Pharmacognosy, (2) Medicinal Chemistry, (3) Biochemistry, (4) Microbiology and Parasitology, (5) Pharmacology and Chemotherapy, (6) Experimental Medicine, and (7) Biophysics.

Personnel

The staff of the institute consists of a Director, 4 Assistant Directors, 8 Senior Scientific Officers, 19 Junior Scientific Officers and an Administrative Officer besides others.

Research Programme**SHORT-TERM PROJECTS**

1. Identification of unknown medicinal plants and development of a herbarium of medicinal plants
2. Preparation of a bulletin on the pharmacognosy of the bark drugs of India

3. Investigation on Indian indigenous drugs reputed to be of value in the indigenous systems of medicine with a view to isolate active principles from the various plant parts
4. Development of economic processes for isolation of physiologically active compounds from plant materials
5. Preparation of liver fractions specifically active against macrocytic nutritional anaemias
6. Preparation of peptones from oilseed cakes and slaughter house wastes
7. Preparation of a modified medium for production of antibiotics and for their assay
8. Preparation of haemostatic agents from oilseeds
9. Preparation of phosphatides and nucleic acids from indigenous plant materials
10. Development of chromatographic techniques for separation of proteins, sugars, antibiotics, hormones, metabolites, etc.
11. Routine screening of drugs isolated from plants or synthesized in the laboratory
12. Study of general pharmacology of some of the more promising drugs
13. Toxicological and metabolic studies of some indigenous drugs reputed to be useful in diabetes
14. Study of some drugs reputed to possess hypotensive and coronary dilatation effects
15. Experimental fatty infiltration and degeneration of liver and effectiveness of lipotropic agents in such conditions
16. Leucoderma and the possibility of its treatment by pituitary melanophore hormone alone or in combination with ACTH
17. Development of methods for *in vitro* and *in vivo* testing of chemical compounds for their activities against Gram-positive and Gram-negative organisms, *M. tuberculosis*, *M. leprae* and amoeba
18. Study of the microbiology of samples of soil from various localities in search of antibiotics
19. Studies in tropical eosinophilia specially with regard to its causative agent, in collaboration with the Lucknow Medical College

LONG-TERM PROJECTS

1. Compilation of a handbook on the botany, chemistry, pharmacology and clinical uses of Indian indigenous drugs
2. Systematic survey of the medicinal plant resources of India
3. Cultivation of medicinal plants of special significance
4. Pilot plant experimentation to increase alkaloidal and other active principle contents of important medicinal plants
5. Physiologically active substances isolated from indigenous drugs with a view to correlate biological activity with molecular structure as a preliminary to fruitful synthetic work along new lines
6. Preparation of new synthetic drugs against (i) mycobacterial infections, e.g. leprosy and tuberculosis, (ii) protozoal infection, such as amoebiasis, and (iii) some neuromuscular blocking agents



CENTRAL DRUG RESEARCH INSTITUTE
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7. Fundamental studies on the action of drugs on enzymes
8. Action of antibiotics on isolated enzymes of plants and of synthetic origin
9. Studies on bacterial enzymes, such as deaminases, dehydrogenases, gelatinases and mucinases of *Vibrio cholerae*
10. Metabolic studies on micro-organisms, including work on growth factors, relation to infection and relation to immunity
11. Pharmacological studies of drugs from various sources, e.g. (i) soil, compost, sewage, etc., (ii) plant, (iii) animal, and (iv) synthetic
12. Biophysical studies on (i) surface action of drugs, and (ii) ionic interaction
13. Study of local action — systemic action, cumulative effects
14. Experimentally produced pathologic state, e.g. smooth muscle spasm, hypodynamic heat, fibrillation, hypertension, respiratory depression, etc.
15. Study of brain waves by electroencephalograph in conditions such as insomnia, mental aberration, schizophrenia, etc., and the effect of drugs evolved, on such conditions
16. Metabolic studies on arthritis and rheumatism and effects of compounds similar to cortisone
17. Electrocardiograph studies on hypertension induced in animals and human subjects
18. Studies on anti-allergic remedies and correlation of protein sensitiveness and dermatological manifestations
19. Investigations into the mechanism of the change of Gram-positive into Gram-negative bacilli on irradiation by ultra-violet rays
20. Studies on *M. leprae*: (i) culture in artificial media, and (ii) production of experimental leprosy in animals, specially in monkeys, through the nerve route
21. Preparation of cell-free medium for the growth of *Ent. histolytica*
22. Etiology of intestinal disorders in which no *Ent. histolytica* or dysentery organisms are detected in stools

Progress of Research

The work of the institute embraces both scientific and industrial aspects but in the initial stages emphasis is on scientific aspects to provide proper background leading ultimately to useful industrial applications. Having a bias for public health work, this institute's activity will naturally take some time before becoming effective in applied fields.

Problems on Hand

PHYTOCHEMISTRY

1. *Cissampelos pareira* Linn. — Detailed studies on the chemical constitution and pharmacological action of the two alkaloids "hayatin" and "hayatinin" in the roots of *C. pareira* reported to be useful in the treatment of fevers, dysentery, asthma and intestinal tuberculosis have been

undertaken. The methiodide of hayatin appears to have some curariform activity and is found to be toxic, depressing the blood pressure and respiration even in small doses. In view of the therapeutic activity of hayatin methiodide as equivalent to d-tubocurarine hydrochloride, attempts have been made to prepare its methyl and ethyl derivatives. A new alkaloid, different from hayatin or hayatinin, has also been isolated.

2. *Rauwolfia densiflora* — An amorphous alkaloid has been isolated from the roots of *Rauwolfia densiflora*. Further work is in progress.

3. *Centipeda orbicularis* — A bitter and an astringent resinous principle has been isolated from the whole plant. A crystalline compound, $C_{31}H_{47}O_2$, melting at 232 C., has also been isolated. Twenty-five products of degradation with hydroiodic acid are being studied further. Thermal degradation with zinc dust in an atmosphere of hydrogen has given a volatile ketone yielding a crystalline 2:4 dinitro-phenyl hydrazone. This as well as the residue from zinc dust are under further examination.

4. *Ailanthus malabarica* — Two bitter principles, melting and decomposing at 217 C. and 153 C. respectively, have been isolated from the stem bark of the plant which is reported to be of value in the treatment of dysentery and bronchitis. The higher melting constituent designated malanthin contains one methoxy and one ketonic group, the main skeleton apparently being steroidal in nature. The lower melting substance is the anhydro derivative of melanthin. Both yield two hydro derivatives each. Two different semicarbazones have also been obtained from them.

5. *Caesalpinia dignya* — A crystalline product, provisionally named "Vakerin", melting at 236°-38°C., has been obtained from the roots. Studies in its constitution are in progress. Results obtained indicate that the vakerin molecule $C_{15}H_{18}O_{10}$ has three hydroxyl groups in the phenolic form, two hydroxyls in alcoholic groupings and a single methoxyl group.

6. *Digitalis lanata* — This plant is used for extraction of its cardioactive glycosides. Experiments have been carried out to evolve an economical method of extraction using solvents easily and cheaply available in India. A modified process for obtaining the lanatosides has been developed. Concentrates of total amorphous lanatosides have been prepared from the leaves. Further experiments are being continued to simplify the method.

7. *Melodinus monogymus* — An alkaloidal principle has been obtained from the plant and is being studied. Attempts are also being made to isolate the bitter constituents.

8. *Rauwolfia serpentina* — Preliminary extraction of the powdered drug was carried out with alcohol. The concentrate thus obtained is being worked up for isolation of the non-alkaloidal fractions for their possible therapeutic activity.

9. *Leucas cephalotes* — Extracts of the powdered flowers and stems obtained from various solvents such as alcohol, chloroform, benzene and petroleum ether are under examination. Analysis of the ash has shown the presence of iron and calcium.

10. *Cephalotus Griffithii* — Investigations on the oil obtained from the seeds of this plant for specific gravity, refractive index, viscosity, saponification value and iodine number have been carried out. Separation of the fatty acids has been effected. Attempts are being made to identify the various acids chromatographically.

11. *Imospora cordifolia* — Extraction of the drug has been undertaken to study the chemical constitution and pharmacological activity of its glucosides.

12. *Euphorbia acaulis* — Tubers of the plant are reported to be effective in the cure of rheumatism and gout and a preliminary examination of the drug has been initiated.

SYNTHETIC CHEMISTRY

1. *Neuromuscular Blocking Agents* — A number of quaternary ammonium compounds are being studied for their curariform activity. A number of quaternary salts of 3:3 dipiperidyl dipropyl ether, N:N bis-(1:2:3:4-tetrahydroquinolyl) diethyl ether, 1:10 dipiperidindecane and of the type N:N-dialkyl (methyl, ethyl, n-propyl n-butyl) bis-piperidylethoxy ethane dihalide have been prepared. Several intermediary compounds and six new bis-tetrahydro-8-methoxy quinolinium compounds carrying a connecting bridge at the 4-4 position and different alkyl groups on the quaternary nitrogen atom have also been prepared. Further synthetic work on potential neuromuscular blocking agents is in progress.

2. *Anti-mycobacterial Compounds* — In view of the marked activity of sulfones against *Mycobacterium leprae*, sulfones variously substituted to obtain correct intercellular permeability and low toxicity have been synthesized. Synthesis of galactosides of various p-alkylamino-p aminodiphenyl sulfones have been completed. Some of the corresponding nuclear substituted sulfones, expected to possess lower toxicity than the parent compounds of the type 4-alkylamino-4 (galactosylamino) diphenyl sulfones have been prepared in sufficient quantities to permit their biological testing as potential anti-mycobacterial agents.

3. *Amoebicides* — Work on synthesis of substituted 8-hydroxyquinoline as potential amoebicides was continued and methods for the synthesis of essential intermediaries were standardized. 4-Alkylamino-8-methoxyquinolines have been synthesized. Synthesis of some 4-substituted-8-oxy (8-methoxy) quinolines and 4-substituted-6-methoxy-8-oxy (8-methoxy) quinaldines has been completed. Work is also in progress on the synthesis of 5:7 dimethoxy-8-oxyquinoline as some of its 4-substituted derivatives.

Synthesis of asymmetric diamines with varying straight and branched chain alkyl and aryl bridges between the two nitrogen atoms is also being continued with a view to testing them against amoebiasis. Synthesis of 8-oxy-quinazolines substituted in the benzene and in the hetero rings has also been undertaken.

BIOCHEMISTRY & IMMUNOCHEMISTRY

1. *Enzyme Inhibition Studies & Elucidation of Mode of Action of Antibiotics* — The action of penicillin, dihydrostreptomycin, aureomycin and chloromycetin has been studied on plant, fungal, animal and bacterial diastatic enzymes. Streptomycin and aureomycin have been shown to activate malt and fungal amylases and chloromycetin to inhibit bacterial amylases.

All these antibiotics have been shown to inhibit liver arginase. The inhibition was reversible by manganous ions and non-competitive in nature. Aureomycin inhibition is competitive in nature.

These antibiotics have very little action on potato phosphorylase. The studies are being extended to animal and bacterial phosphorylases.

These antibiotics were found to have very little action on radish peroxidase.

Investigations on the effect of antibiotics on kidney alkaline phosphatase have been completed.

Enzyme inhibition studies have been extended to succinic oxidase, dehydrogenase-cytochrome oxidase systems derived from heart muscle pulp. The succinic oxidase was found to be unaffected by antibiotics. The dehydrogenase system was inhibited up to 50 per cent by aureomycin and terramycin. The action of antibiotics on cytochrome oxidase is being studied to elucidate the mechanism of inhibition. Allied factors influencing inhibition are also being investigated. Isonicotinic acid hydrazide — the new anti-tubercular drug — has been included in this study along with other antibiotics. Preliminary screening against the enzyme from *E. coli* has shown that aureomycin and terramycin are inhibitory.

Attempts were made to prepare an active xanthine oxidase from fresh milk for studying the effect of antibiotics.

Work is in progress on the development of antibiotics for specific pathogens by using the principle of induced antagonism.

Vitamin C metabolism in thermal burns, injury and toxemia is being studied.

A modified Aronson fuchsin sulphite agar medium has been developed which permits differential isolation of *V. cholerae* from fixed cultures even in the presence of certain non-agglutinable vibrios.

Therapeutic efficiency of Flavozole (0.3-0.4 per cent) was compared with routine dressings. Flavozole was found to be more effective than acriflavine glycerine 2 per cent or sulphathiazole 5 per cent ointment.

2. *Investigations on Lecithins* — Fairly large yields of lecithins (1.5-1.6 per cent) have been obtained from two Indian pulses, *Cajanus cajan* and *Phaseolus mungo* (Arhar dal and Urd dal). Semi-large-scale preparation of the phosphatides has been undertaken for nutritional studies.

3. *Chromatographic Studies* — Detection of enzymatic activity by paper chromatography has been undertaken. Chromatographic analysis of general acids by acid solvents has also been completed. Effect of moisture, pH, etc., on the R_f values of the acids analysed has been studied in detail. Chromatographic analysis using basic solvents is also in progress.

4. *Experimental Production of Anaemia & the Fractionation of Liver* — Investigation on the blood picture changes associated with development of experimental lead anaemias in the rat was continued. The beneficial effect of known haemopoietic agents has been confirmed by injecting vitamin B₁₂ and liver extract simultaneously with lead acetate. The dose response relationship of vitamin B₁₂ was studied. It was found that maximum response was obtained when the dose was raised to 1.6 µg./100 g. body weight. The type of anaemia developed by the injection of lead acetate is being studied.

Metabolism of tyrosine and phenyl-alanine in the anaemic rats was also studied. It was observed that tyrosine metabolism was profoundly altered by the onset of anaemia. Vitamin B and other methylating agents are being studied with a view to studying tyrosine excretion. Investigations on the oxidative metabolism of tyrosine have also been undertaken. Preliminary studies indicate that the metabolic rate is considerably decreased in lead anaemia.

5. *Preparation of Peptones* — Dry samples of peptone-like products have been obtained from some Indian oilseed cakes. Attempts have been made to prepare the peptone-like product from oilcake hydrolysates on a large scale.

6. *Enzyme Make-up of Vibrio cholerae* — The deaminase, gelatinase, mucinases and dehydrogenases of *V. cholerae* have been studied. Factors



CENTRAL DRUG RESEARCH INSTITUTE
ANIMAL HOUSE

influencing the activity of aspartic acid deaminase system of *V. cholerae* have been studied in detail. Activation and inhibition studies have indicated that the enzyme is dependent on intact -SH groups, aldehyde or keto groups, amino group and metals like Mg for its activity. Deamination of aspartate was an aerobic oxidative reaction and was found to follow a second order reaction.

Gelatinase activity was studied by the standard viscometric method. Various factors like age, strain, addition of gelatin to medium, etc., affecting the production of gelatinase by *V. cholerae* have been studied. Inhibition and activation studies indicate that the enzyme is sulphhydryl in nature. The Water vibrio was found to have the maximum activity. Effect of cyanide, ascorbic acid and certain antibiotics was also studied.

Washed cells of *V. cholerae* have been shown to have no mucinolytic action. Attempts were made to determine the mucinase activity of *V. cholerae* by viscosity method using glandular oxomucins.

Dehydrogenase activity of Ogawa and the Inaba and Rough sub-types derived from it has been studied on glucose, lactate, succinate, formate, glutamate, alanine, histidine, leucine and isoleucine substrates.

Phosphatase activity of *V. cholerae* strains is being studied.

7. *Polysaccharide Production from Vibrios* — Work on the production of the immunologically active polysaccharides of vibrios has been continued.

8. *Absorption & Excretion of Amino Acids by Vibrio cholerae* — The absorption and excretion patterns of various amino acids by *V. cholerae* have been studied by two-dimensional paper chromatography. Aspartic acid, cysteine and cystine were found to be absorbed. Alanine was found to be excreted in most of the cases. Glutathione was found to be split up presumably by a tripeptidase. Cystine was taken up.

9. *Factors Affecting the Autolysis of Vibrio cholerae* — The course of autolysis of vibrio in normal saline and phosphate buffer has been studied at 37°C. Factors affecting this autolysis have also been studied. The medium used for suspending the resting cells of the organism for the assay of enzyme activity seems to exert a profound influence on stability which is presumably linked with a co-enzyme. The effect of rosaniline dyes on *V. cholerae* is also being studied.

10. *Nutritional Requirements of Vibrio cholerae* — The effect of vitamins and growth factors on *V. cholerae* has been studied. Thiamin, vitamin B₁₂ and folic acid were found to accelerate the growth.

1. *Growth Curve of Vibrio cholerae* — Thirty different strains and sub-types of *V. cholerae* have been studied in natural medium and their growth curves have been plotted. Effect of aeration and allied factors are being studied. A medium consisting of salts and glucose has been developed for the growth of *V. cholerae*.

2. *Metabolic Studies on Vibrio cholerae* — Respiration of several strains and sub-types of *V. cholerae* has been studied in the presence of different sugars, amino acids and organic acids involved in intermediary metabolism. Lactic acid, cystine, alanine and pyruvic acid were found to be rapidly metabolized by all the strains. It was found that the organism makes use of the tricarboxylic acid cycle in intermediary metabolism.

3. *Preparation of Lactic Acid* — Work has been initiated on the preparation of lactic acid from molasses by fermentation. A lactic acid bacillus is being studied for its fermentative and biochemical characteristics.

4. *Preparation of Diastatic & Tryptic Enzymes* — Optimum conditions of growth, media and related factors have been worked out for *B. subtilis* enzyme to prepare highly active diastatic and tryptic enzymes.

Highly active diastase and tryptic preparations were obtained from two media. Effect of aeration of the growth culture of *B. subtilis* on the production of enzyme was also studied. In 24 hr. the activity of the aerated culture was higher than the stationary one although on prolonged aeration this was reversed. Standardization of experimental conditions for suitably harnessing this property in the production of enzyme is being attempted.

15. *Preparation of Nucleic Acids* — Work was initiated on the preparation of nucleic acids from plant materials.

16. *Antibiotics from Higher Plants* — Work has been undertaken on the isolation and characterization of indigenous drugs from higher medicinal plants. An antibiotic from the plant *Aristolochia indica* has been found to be effective against *S. aureus* (*in vitro*) and is being systematically studied.

MICROBIOLOGY & PARASITOLOGY

Experiments on the evaluation of drugs in tuberculosis in laboratory animals were continued. Four drugs of the sulfone group, synthesized in the laboratory, are also being tried on tubercular guinea-pigs. *In vitro* testing of highly insoluble drugs against *Mycobacterium tuberculosis* was continued.

Investigations were continued on the etiology of various cases of chronic diarrhoea and on *Ent. histolytica*. Further evidence was collected on the virus etiology of tropical eosinophilia.

1. *Antibiotics from Soil Micro-organisms* — Twenty-three soil samples collected locally have been screened for molds. Twenty of these have been grown in liquid medium and screened for antibiotic activity and isolation of actinomyces. Some have shown promising results.

2. *Influence of Ultra-violet Rays on Gram-negative & Gram-positive Organisms* — It was observed earlier that smears of various Gram-negative organisms exposed to ultra-violet rays get changed into Gram-positive. Live cultures of the various Gram-negative organisms have been grown in presence of minute doses of ultra-violet light to study the nature of the induced change.

PHARMACOLOGY & ENDOCRINOLOGY

1. *Curariform Drug* — An intensive search has been carried out in order to find out a natural or synthetic substitute for curare, a drug popularly employed in bringing about muscular relaxation in surgical work. A curariform substance isolated from the roots of *Cissampelos pareira* has given encouraging results and has been named hayatin methiodide. Its extended clinical use is being contemplated.

Pharmacological investigations on the active principles of *Picrorhiza kurroa*, *Nardostachys jatamansi* and *Luffa amara* have been undertaken.

Investigations on absorption, metabolism and excretion of DDS (diamino diphenyl sulfone) and its derivatives are being carried out.

Pharmacological investigations of chaksine, an alkaloid isolated from *Cassia albus* Linn., have been completed.

2. *Studies on ACTH-Melanophore Hormone Relationships* — It has been demonstrated that the injection of a highly purified preparation of

melanophore hormone fails to evoke changes in the adrenal cortex of mice similar to those produced by ACTH. This finding is a strong evidence against the concept that the two hormones are identical.

Prolonged administration of ACTH to kittens has been shown to cause a hypertrophy of the basophil cells of the *pars intermedia* of the pituitary and cytological changes resembling the hyaline changes of Crooke. These changes indicate an altered physiological state of the basophils and probably an enhanced output of melanophore hormone. Besides, preliminary assay of the pituitary of adrenalectomized rats treated with ACTH shows an increased output of melanophore hormone. These findings suggest that ACTH stimulates the basophil cells to produce greater amounts of melanophore hormone, and that this is a direct effect of the former on these cells. The implication of these observations is considerable as they furnish an experimental evidence that the skin pigmentation alleged to be induced by ACTH is probably due to melanophore hormone.

3. *Studies on the Melanophore Hormone of the Pituitary & Its Use in the Pigmentary Disorders of the Skin*—The melanophore hormone has been shown to stimulate synthesis of melanin pigments particularly in the snout region of frogs (*Rana tigrina*).

4. *Studies on the Use of Male Sex Hormone in Hypothyroidism*—It has been shown that androgen prevents cystic changes in the ovary of hypothyroid rats and influences hyperplasia of the thyroid epithelium associated with hypothyroidism and brings about a rise in cholesterol concentration of the adrenals indicating an alteration in their normal functioning state in hypothyroidism.

5. *Studies on Physiological Properties of Hormones with particular Reference to Hormone Interactions & the Relationships of Hormones with Enzymes & Vitamins*—It has been demonstrated that progesterone has a synergistic effect on androgenic action of testosterone on the seminal vesicles of mature castrated rats.

Serum gonadotrophin, testosterone and progesterone have been shown to produce varying degrees of atrophy of the adrenal cortex in rats. This is correlated with the depletion of ascorbic acid from the gland.

It has been shown that adrenalectomy causes a loss of phosphatase activity from the genital organs of the female rats. DCA therapy restores the normal distribution and activity of the enzyme in the genital organs.

Ovariectomy has been shown to induce typical diestrus pattern of phosphatase distribution in the vaginal smear of rats. Estrogen therapy causes a loss of phosphatase activity from the vaginal smear elements as in normal estrus.

6. *Studies on "Stress" Syndrome*—It has been demonstrated that the exhaustion of the adrenal cortex due to excessive stimulation with a stressor agent like ACTH is associated with a total depletion of ascorbic acid from the parenchymal cells as well as from the vascular sinusoids with a loss of phosphatase activity from the adrenal cortex in response to stressor agents like ACTH and tubercular bacillus.

DIVISION OF EXPERIMENTAL MEDICINE

1. *Pathogenesis of Vitiligo*—Studies in the histopathological difference between white and black skins of animals and human beings have been undertaken. Biopsy studies have now revealed that melanin is completely absent in the leucodermic patches of patients.

Studies in the response to the action of ultra-violet ray therapy with nicotinic acid treatment are in progress. The minimal erythematol dose of the leucodermic skin is observed to be higher than that of normal, both in pigmented and depigmented areas.

2. *Blood Volume & Thiocyanate Space in Health & Disease* — Blood volume and thiocyanate space of dogs has been determined using the photoelectric colorimeter. Similar experiments on normal and cardiac human patients are in progress.

3. *Nephritic Anaemia in Relation to Toxicity & Deficiency Factors* — Experimental, biochemical, clinical, statistical and therapeutical aspects of the investigation have been taken up in collaboration with the local medical college.

4. *Antibiotic against Shiga* — Preliminary work on the isolation of an antibiotic from an aerobic spore-forming bacillus has been completed.

Aid to Industry

Attempts have been made to solve the problems of many firms, and technical aid given to a large number of organizations, drug industries, private concerns and individuals requiring information on drugs and pharmaceuticals. With the establishment of a newly created Analytical Wing, it will be possible to give complete aid to all the industrial concerns that approach the institute.

CENTRAL ROAD RESEARCH INSTITUTE, DELHI

Introduction

THE need for a Central Road Research Institute for conducting research work on problems connected with the construction and the maintenance of all kinds of roads was emphasized for the first time in a conference of Chief Engineers of Provinces and States held at Nagpur in 1943. A year later definite proposals for the establishment of the institute were initiated in consultation with the Consulting Engineers (Roads) to the Government of India and a detailed plan was accepted by the Council in 1945. The Central Road Research Institute was opened formally by the Prime Minister of India, Shri Jawaharlal Nehru, on 16 July 1952.

Scope & Functions

The important functions of the institute are: (1) fundamental research on materials for road construction; (2) correlation of laboratory tests with those under actual conditions; (3) tests on soils and studies of soil mechanics with a view to evolving low cost roads; (4) standardization of specifications for roads, including road building, plant and machinery; (5) technical advice and assistance on road construction, maintenance and failures; (6) application and development of instruments for tests on



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roads for the measurement of irregularities of road surfaces, impact factors, traffic counters, etc.; (7) studies on the characteristics of different types of roads under different traffic conditions (incidence of accidents, road safety and road statistics); (8) co-operative research schemes and co-ordination with other institutes, universities and industrial institutions; (9) dissemination of results of research for the benefit of road engineers; and (10) training of technical personnel.

Divisions

The technical work of the institute is organized in five Divisions dealing with (1) Soils, (2) Rigid Pavements, (3) Flexible Pavements, (4) Roads, and (5) Traffic Engineering, Economics and Statistics.

Personnel

The technical staff of the institute consists of a Director, 5 Assistant Directors, 6 Junior Scientific Officers, 7 Senior Scientific Assistants and an Administrative Officer besides others.

Research Programme

The technical work in the institute began in October 1950.

1. *Investigations on Surface Dressings*—In the years 1944-46, the Indian Roads Congress, on behalf of the Roads Organization, laid special test specifications on surface dressings on several national highways in India. One of these was on the Delhi-Bombay Road, near Agra, on the Gwalior State border. The test roads were used by a mixed traffic of about 460 tons a day for about six years and their behaviour was investigated by the institute.

From a study of the results of investigation into the residual binder content of the surface dressings it seemed probable that an equally good surface dressing would have remained had a smaller quantity of binder (both bitumen and tar) been used each time whether the primer was used or not. With tar the primer should not be necessary. The combination of bitumen binder and a bitumen primer is more advantageous as compared with the bitumen without a primer. By using a primer it should be possible to save bitumen by getting a normally deeper penetration than would be obtained without a primer.

In summer 1953 a Test Track, more than half a mile long, was opened on the Delhi-Bombay Road, in the institute's premises. Attached to the Test Track is a diversion meant as a second test track of the same length. The Roads Organization of the Ministry of Transport, Government of India, and the Public Works Department collaborated in the construction of the test track, the costs, about Rs. 1 lakh, being borne by the Roads Organization.

2. *Soil Stabilization in Kashmir*—The problem was studied and the Kashmir Government was advised about the use to which the soil in question could be put and its suitable stabilization. Usual stabilizers transported from the plains were found to be uneconomical due to the high cost of transportation.

3. *Road Signs & Signals* — In the International Committee of the United Nations Economic & Social Council on Road Signs & Signals, certain symbols, specially danger warning signs, regulatory signs and informative signs, had to be developed for use on roads and in city traffic inhabited by literate and illiterate persons, and at the same time conforming to standards accepted in other countries. Recommendations made in collaboration with other authorities were finally adopted by the International Committee.

4. *Compaction of Alluvial Soils* — A study of compaction of three alluvial soils and a sand generally available in north-west India was carried out with a 7-ton smooth-wheeled roller, a pneumatic-tyred roller and a taper-foot sheepfoot roller on a straight open test track to compare their performance on different soils and to determine the effects of moisture and the number of passes of the plant on the resultant dry density of the soils. It was concluded that when high density can be sacrificed for economy, working on the wet side of the optimum moisture content can be recommended. Although it is hard to reproduce field conditions, laboratory compaction tests serve as a useful guide for field work. The conclusions drawn at Road Research Laboratory, Harmondsworth (London), are also applicable to some typical Indian soils. The effect of sheepfoot roller is, however, different.

5. *Design of Bullock-cart Wheel Tester* — To be able to investigate into the durability and economics of various designs of bullock-cart wheel-axle systems, a machine, the "Wheel Tester", was designed and constructed. This machine, for which the final attachments are still to be designed, was built to improve the efficiency of bullock-cart traction which is still an important sector of the traffic in India.

6. *Investigations on Two Runways* — Case I — Examination of the first runway showed that the applied binder covered the grit with a very thick coat which did not adhere well, and resulted in a flow of the binder from the surface into the lower portions of the top carpet.

For repairing this surface, it was advisable to retain the present sub-base, sub-coat and surface layer. The well-compacted and dense new surface layer, while offering enough friction for retarding the speed, should also be smooth enough to keep the tyre wear within reasonable limits.

Case II — Examination of the second runway revealed that two kinds of aggregate had been used, one with normal specific gravity containing nominal percentage of organic matter and the other with low specific gravity showing high percentage of organic matter. The second kind of aggregate could be called coal-metal.

Gradual loosening of the contacts of the coal-metal pieces with the cement mortar had occurred due to its lightness and oxidation.

These investigations have led to the conclusion that the defects in the runway and apron had nothing to do with any special lubricant used by the aircraft. Due to the hot sun, the coal-metal disintegrated and resulted in destruction and discolouration of small areas.

For strengthening this pavement, a carpet of black-top paving should be adopted. This will make up for the reduced thickness and oxidation will take place at a very low rate.

7. *Investigation on Laterites* — This investigation was undertaken in order to find out whether a particular kind of laterite can be used for construction of the water-bound-macadam top crust of a road of more than 100 miles length while opening up a region. No stone material was available in the region investigated and laterite was the only material available.

Investigations showed that six types of laterite can safely be used for road construction when conditions would permit the use of materials of similar hardness like bricks, and can readily serve as a soling and may also be used as an inferior road metal. To use it as "chippings" for the top layer in water-bound macadam roads, careful sieving should be adopted to get rid of the fine and soft fractions released by crushing the material.

8. *Compaction of Tensile Briquettes* — While preparing standard specifications for cement, aggregate and concrete it was found necessary to investigate different methods of compaction of tensile briquettes in cement testing to discover the extent of uniformity of test results obtained by different methods, and to recommend a simple method which would eliminate, as far as possible, the "personal factor" and give consistent and reproducible results. The compaction of the briquettes was done using Ennore sand (Madras), recently declared as the standard sand for India.

9. *Failure of a Concrete Road* — It was observed that certain concrete slabs had disintegrated heavily as against certain other slabs which were in perfect condition on a newly constructed municipal concrete road. With the investigations conducted it was possible to eliminate the defects.

10. *Studies on the Stabilization of Black Cotton Soils* — Black cotton soils in India can now be classified into three groups, each with clearly defined limits and properties. The problem of stabilizing them is under investigation. This will enable the soils to be classified and also effect economy for construction purposes.

Technical Aid

Close connection and collaboration with the Roads Organization of the Ministry of Transport, Government of India, was one of the essential conditions for useful work and the great encouragement received from this quarter helped the work of the institute in the early stages. Close liaison was also envisaged between the Central Road Research Institute and other research and experimental stations, especially with organizations like the Engineer-in-Chief's Branch of the Army Headquarters, the Indian Roads Congress and the Indian Standards Institution, and this objective has since been realized.

The institute has established close relations with similar institutions in the U.K., on the Continent, in the U.S.A., Australia and other countries of Asia, and technical information is continuously exchanged.

In many cases the institute was entrusted with occasional or continuous control of concrete work by testing concrete cubes. In several cases, this control developed into a complete control of the quality of the cement and concrete used; in other cases the institute advised on control procedures and gave complete designs of mixes. Important construction works have been done in this way, collaborating closely with the interested parties.

In several cases technical advice was given to planning and executive authorities for determining the actual load-bearing capacity of the ground for the new building of the Reserve Bank of India and the Supreme Court at Delhi and for various buildings at Chandigarh.

CENTRAL ELECTRO-CHEMICAL RESEARCH INSTITUTE KARAIKUDI

Introduction

A SCHEME for starting a national research laboratory for electro-chemical research was accepted by the Council in 1944. The Industrial Research Planning Committee also gave their support to the scheme. The location of the institute was not, however, decided till 1948 when, in view of the generous donation of Rs. 15 lakhs and 300 acres of land by Dr. Rm. Alagappa Chettiar, it was decided to establish the institute at Karaikudi. The foundation-stone was laid on 25 July 1948 by the Prime Minister, Pandit Jawaharlal Nehru.

Scope & Functions

The functions of the institute are to (1) foster basic or fundamental research in chemical reactions promoted by electricity; (2) undertake investigations to increase the productive capacity and efficiency of existing industries; (3) set up pilot plants for demonstrating promising laboratory researches, having industrial potentialities; (4) evaluate raw materials, and standardize finished products; (5) collect technical information and data pertaining to industrial statistics and disseminate the same; (6) train technologists; and (7) organize and maintain a museum for display of electro-chemical products and flow charts of important processes.

Divisions

The work of the institute is divided into (1) Electro-metallurgy and Furnace Products, (2) Electrolytic Cells, (3) Electro-deposition and Allied Processes, (4) Fundamental Electro-chemistry, and (5) Research Utilization and Information.

Personnel

The staff of the institute consists of a Director, an Assistant Director, a Senior Scientific Officer, 2 Junior Scientific Officers and an Administrative Officer besides others.

Problems on Hand

The following are the important research problems being tackled: (1) Formation and decomposition of formaldehyde under the influence of high-tension electric discharges. (2) electro-polishing of hard chrome-plating of bearing surfaces of piston rings of internal combustion engines and locomotive engines. (3) preparation of cuprous oxide for use in anti-fouling paints required by the Navy; laboratory work has given promising results. (4) preparation of pure potassium chlorate to meet ordnance specifications. (5) electro-chemical oxidation of glucose to calcium gluconate. (6) electrolytic reduction of nitrobenzene to para-aminophenol for use as a dye intermediate and as a photographic developer. (7) electrolytic



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reduction of salicylic acid and benzoic acid to salicyl aldehyde and benzaldehyde; (8) production of manganese metal from low grade manganese ores; (9) formation of anodic oxidation films on aluminium and their colourization; (10) preliminary investigation on some of the newer types of primary wet cells, viz. water activated cuprous chloride-magnesium, silver chloride-magnesium cells; lead cells having soluble reaction products; primary wet cells employing magnesium as consumable anode; these are light in weight but give high power and constant voltage; (11) production of heavy water; (12) reclamation of aluminium scrap to make secondary aluminium; (13) electro-deposition of brass and other alloys from non-cyanide baths; (14) electrolysis of sodium sulphate; (15) electro-deposition of tin-zinc alloys from cyanide-free alkaline bath; (16) electrolytic production of titanium; (17) preparation of high-test hydrogen peroxide; (18) electro-deposition of rubber; (19) electrolytic preparation of chemical lead; (20) electrolytic production of potassium permanganate; (21) preparation of aromatic aldehydes by reduction of aromatic acids; (22) polarographic analyses; and (23) production of calcium carbide.

Industrial Research Problems Completed

High purity manganese metal is now produced on a small semi-pilot plant scale of 3 lb. per day and a slightly larger pilot plant for the production of 10 lb. per day is under fabrication.

Investigations on the production of para-aminophenol calcium gluconate, preparation of cuprous oxide and reclamation of aluminium scrap have been successfully completed in the laboratory. Pilot plants for these investigations are being set up.

Aid to Industry

During the short period the institute has been functioning, technical advice on several subjects has been tendered to industrialists, on request. Investigations have been undertaken to provide technical aid to interested industrialists in solving their difficulties.

CENTRAL LEATHER RESEARCH INSTITUTE, MADRAS

THE Leather Research Committee recommended the establishment of a Central Leather Research Institute. This recommendation was strongly supported by the Industrial Research Planning Committee. The recommendation was accepted by the Council and it was decided to locate the institute at Madras, one of the main centres of leather industry in India. The Government of Madras made a gift of 84 acres of land in the Guindy area and reclaimed it at their own cost. The foundation-stone of the institute was laid on 24 April 1948, by Dr. Syama Prasad Mookerjee, the then Minister for Industry & Supply. The opening ceremony of the institute was performed by Shri T. T. Krishnamachari, Minister for Commerce & Industry, on 15 January 1953.

Scope & Functions

The main function of the institute is to assist the Indian leather industry through fundamental and applied research, training of leather technologists and dissemination of technical knowledge.

Researches on the various aspects of leather manufacture may be classified into three broad categories: (1) fundamental work on the histology of hides and skins; physical structure and properties of hide and skin fibres; chemical constitution of hide and skin proteins; (2) applications of chemistry, physics, bacteriology, microscopy and other branches of science in tanning and production of leather; mechanism of tanning and process control; vegetable tannins, mineral tanning agents and tanning auxiliaries; and (3) developmental research, including investigations on adaptation of processes and manufacture of leather auxiliaries from indigenous materials; pilot plant work; trials on tanning auxiliaries and their performance in industrial practice.

Training of Technologists — Indian leather industry requires a continuous supply of trained technologists. The A. C. College of Technology, Madras University, started a degree course in leather technology with the help of an annual grant of Rs. 60,000 from the Council of Scientific & Industrial Research. With the establishment of the Central Leather Research Institute, the responsibility for training leather technologists has been taken over by the institute.

Dissemination of Technical Information — Technical information of value to the Indian leather industry is disseminated through bulletins and articles published in scientific and leather trade journals and by supplying information in response to specific enquiries. Since May 1951, the institute has been issuing a monthly technical bulletin containing abstracts of current literature in leather technology.

Divisions

The work of the institute is divided into five Divisions: (1) Chemistry and Physics, (2) Biology, (3) Tanning and Finishing, (4) Publicity and Intelligence, (5) Chemical Engineering.

Personnel

The staff of the institute consists of a Director, an Assistant Director, a Senior Scientific Officer, 3 Junior Scientific Officers and an Administrative Officer besides others.

Research Programme

SHORT-TERM RESEARCH

1. Research on curing of hides and skins with Didwana salt by wet and dry salting
2. Adaptive research on tanning processes to improve the quality of (a) shoe upper leather (box and willow sides)



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- (ii) Shoe upper leather (glaced kid)
 - (iii) Industrial leather (picking bands)
 - (iv) Sole leather
 - (v) Belting leather
 - (vi) Industrial leather (roller skins)
 - (vii) Chamois leather
 - (viii) Light fancy leathers
3. Manufacture of Army retan leather for military boots
 4. Manufacture of chrome belting leather
 5. Fixation of standard specifications for various types of leather
 6. Impregnation of sole and in-sole leathers with rubber and other polymeric materials to increase their wear resistance
 7. Motor car and furniture upholstery leather
 8. Production of sodium sulphhydrate
 9. Production of enzyme bates from animal pancreas, fungus or vegetable sources of proteolytic enzymes
 10. Manufacture of basic chromium and aluminium sulphates and basic combined aluminium and chromium sulphates for tanning
 11. Manufacture of commercial fat liquors from Indian animal and vegetable oils
 12. Manufacture of casein pigment finishes for leather
 13. Manufacture of nitrocellulose lacquers for upholstery leather
 14. Shoe polishes
 15. Sole stains

LONG-TERM RESEARCH

1. Indian vegetable tanning materials as substitutes for wattle bark
2. Tanning extracts from Indian vegetable tanstuffs
3. Chemical constitution of tannins of principal vegetable tanstuffs of India like barks of babul (*Acacia arabica*), avaram (*Cassia auriculata*), goran (*Ceriops roxburghiana*) and of myrobalan (*Terminalia chebula*)
4. Chromium and aluminium complexes in tanning salts
5. Chemistry of skin proteins with particular emphasis on the constitution and properties of collagen
6. Synthetic tanning materials or syntans
7. Synthetic oils for tanning industry
8. Mechanism and principles involved in flaying, salt curing, drying, soaking, liming, bating, etc.
9. Chemical mechanisms of different tannages now in commercial use
10. Mechanism of fat liquoring and dyeing of vegetable and chrome tanned leathers
11. Development of tanning processes with newer tanning materials like di-isocyanates, glyoxal and resins
12. Tanning properties of salts of zirconium and salts of rare earths like cerium

13. Synthetic resin based pigment finishes for leather
14. Microscopic research on the histology of raw hides and skins for controlling processes of leather manufacture and for assessing quality of leather
15. Bacteriological research on the operations involved in leather manufacture under the conditions obtaining in India
16. Biochemical research on enzyme dehairing and bating

Industrial Research Problems Completed

CHEMISTRY & PHYSICS DIVISION

1. *Application of Myrobalan Extract in Place of Myrobalan Nuts in the E.I. Tannage of Kips & Skins* -- In E.I. tanning, myrobalan nuts are used in final stages of tanning for producing an attractive yellowish cream colour on the leathers and for improving the yield. Desirable effects are obtained by the use of myrobalan nuts but research investigations have shown that much of the tanning material is not utilized and goes to waste. It has been shown that if a chemically treated myrobalan extract is used instead of the nuts, the desirable effects are obtained with complete avoidance of wastage of valuable stuff. The process has been patented.

2. *Basic Salts of Aluminium as Tanning Agents* -- Alum and salt tanning for producing white leathers and dressing fur skins was modified and the disadvantages of the old process were rectified. A novel process for the manufacture of basic salts of aluminium, namely basic aluminium sulphate and basic aluminium chloride, having a basicity ranging from 0 to 100, was evolved. These salts have been tested with success as tanning agents. Processes have been worked out for the use of these basic aluminium salts as tanning reptile skins which also find export market. Patent applications have been filed.

3. *Synthetic Tanning Materials* -- Indian vegetable tanning industry now depends to a large extent on imported tanning materials, namely wattle bark and mimosa extract, imported from East Africa. To supplement and substitute the imported tanning materials, research has been undertaken to produce synthetic tanning materials or syntans from coal tar distillation products such as phenols, cresols, naphthalane, etc., and also from natural sources. Twenty-nine syntans have been produced in the laboratory and tested with success for their tanning properties. Various syntans can be used as auxiliaries or in combination or as independent tanning agents to produce leathers of good colour and strength. Pilot plant experiments are being conducted to produce some of the syntans for introduction into Indian tanning industry. Further research to produce other syntans is in progress.

4. *Synthetic Leather Oils* -- Vegetable oils like groundnut and castor, and animal oils like fish oils are used in the tanning industry but some of the oils used are either in short supply or too costly. Research shows that vegetable and animal oils can be easily substituted by these synthetic oils in fat liquoring and also as tanning agents for making chamois leather. Attempts are now being made to prepare the oils on a pilot plant scale.



CENTRAL LEATHER RESEARCH INSTITUTE —
TANNERY BLOCK

5. *Use of Divi-divi in Tanning* — Divi-divi, an indigenous tanning material, rich in tanning content, is in abundant supply but it is not a popular tanning material because the tan liquor prepared from it ferments readily and imparts a dark colour to the leathers. A chemical process has been discovered to prevent the fermentation and to stop the development of dark colour on leather.

6. *Combination Mineral Tanning Agents* — New processes have been worked out for the manufacture of combination mineral tanning agents, namely (i) chrome-aluminium, (ii) aluminium-iron, and (iii) aluminium-chrome-iron. These have been found to have good tanning properties and processes for the production of good quality leathers by their use are being worked out.

7. *Chrome-vegetable Combination Tannage* — A new process has been developed to produce a combination chrome-vegetable tanning agent having properties of both chrome and vegetable tanned leather. This tanning agent has been utilized with great success for the production of leathers like glace kid, suèdes and roller skins. The results are under publication.

Standardization Work

At the instance of the Indian Standards Institution much work is being done for obtaining data for standard specifications for different types of leathers. Among problems under study are: (i) curing of hides and skins with Didwana salt by dry salting process and by Mettur salt; (ii) studies on the traditional E.I. tanning processes for skins and kips; (iii) systematic investigation of indigenous tanstuffs of the Madras State; (iv) substitution or supplementation of imported and costly materials like wattle and quebracho extract; (v) isolation, purification and determination of the chemical constitution of avaram bark tannin; (vi) evaluation of the vegetable tanning materials for their weight giving properties in sole leather tannage; (vii) preparation of synthetic tannins from coal tar distillation products and from natural phenolic bodies; (viii) nature of mineral tanning agents such as chrome, aluminium, iron, zirconium, alone or in combination; (ix) preparation of synthetic leather oils for use in leather manufacture, and as tanning agents; (x) preparation of commercial fat liquors from non-edible vegetable and other oils; (xi) preparation of sodium sulphhydrate for use as a depilatory in leather manufacture; (xii) acid and salt ratios of vegetable tanning materials; (xiii) data for fixing standard specifications for Indian chamois leather; (xiv) impregnation of sole leather with polymeric materials to increase its abrasion and water resistance; (xv) weight giving properties of commercial tanning extracts; (xvi) investigation on barks of mangrove, *Bruguiera gymnorhiza* and *Rhizophora mucronata* from Andamans; (xvii) degree of tannage attainable by different tanstuffs; (xviii) strength of liquors possible from different Indian tanstuffs; (xix) testing of pit tanned and bag tanned sole leather for a comparative study of their properties; and (xx) aldehyde tannages.

BIOLOGY DIVISION

Dehairing by Enzymes — It has been shown that latex of certain plants contains enzymes that may be used for dehairing hides and skins. These enzymes have been isolated and purified and it has been found that the

purified enzyme produces simultaneously both dehairing and bating. This process will reduce dehairing time from 15-20 days to 15-20 hr.

Study of the Red Hairy & Wool Sheep Skins

Red-haired sheep occur in large number in Madras State. Their skins are longer and stronger than those of wool sheep. The cause of the superiority of the hairy sheep skin is being studied.

Photomicrographic Study of Processes & Finished Leather—Photomicrographic study has explained effects of soaking, liming, bating and pickling on the properties of the final leather.

Other subjects under investigation include:

- (i) Photomicrographic study of E.I. kips to correlate fibre structure with quality and to find out standard microscopic specification
- (ii) Microscopic study of pit and drum tanned sole leather to investigate their quality
- (iii) Histological studies of raw hides and skins to find out differences in the fibre structure of Indian and imported picking band leather and also to find out a relation between angle of weave and tensile strength
- (iv) Photomicrographic investigations into the fibre structure of E.I. kips tanned with various Indian tanstuffs to find out a substitute for imported wattle bark
- (v) Bacterial action during liming
- (vi) Isolation of bacterial strains which probably cause "red stains" on salted skins
- (vii) Production of enzyme bates and proteolytic enzymes from proteolytic strains of certain molds, viz. *A. niger*, *A. oryzae*, *A. flavus* and *A. parasiticus*
- (viii) Use of mucolytic enzymes in dehairing and bating and suitability of a few mucolytic enzymes, e.g. diastase, pectinase, etc., in dehairing and bating of skins and hides
- (ix) Treatment of tannery effluents to make them unobjectionable

TANNING & FINISHING DIVISION

1. *Shoe Upper Leathers like Box & Willow Sides & Glace Kid*—Shoe upper leathers like box and willow sides manufactured in India from indigenous cow hides are inferior in quality and do not fetch a proper price in foreign markets. Research is being carried out to adapt foreign processes to improve the quality of Indian box and willow sides. Seven processes have already been adapted and found to produce good leather. About 90 per cent of 22.9 million goat skins annually produced in India are exported, chiefly to U.S.A., where they are manufactured into a high class shoe upper leather, glace kid. To establish manufacture of glace kid in India and export the tanned and finished leather in place of raw skins, ten processes for the manufacture of good quality glace kid have already been worked out. These are being published in the form of a bulletin for information of the Indian tanning industry.

2. *Industrial Leathers*—Roller skins used in spinning mills, picking bands used in jute and cotton textile mills and leather beltings used in factories

and workshops are mostly imported at present. Seven processes for making picking bands, two processes for making roller skins have been worked out and samples have been sent to mills for practical tests.

3. *Rapid Sole Leather Tannage* — In India usually pit tanning is employed for the manufacture of sole leather but the process is slow and takes nearly 3-4 months to complete causing capital to be locked up for a very long time. A process for rapid tannage would obviously be more economical. So far three processes have been worked out to produce good sole leather reducing the time from 3-4 months to 3-6 weeks. An interesting feature is that some of these processes can well be adopted even by the village tanner, who has no modern equipment. The leathers produced are easily marketable and have been in great demand.

4. *Wattle Bark* — Vegetable tanning materials are in short supply in India and tanning industry largely depends on the imported wattle bark and its extract imported from East Africa. The dependence of the industry on foreign countries for these basic raw materials is highly undesirable. India abounds in indigenous tanstuffs and an exhaustive survey of the indigenous tanstuffs has been undertaken to find out substitutes for wattle bark and extract. Modern techniques like acid-salt control are also being applied. The results so far obtained indicate that certain indigenous materials like karada, mangrove and white valem barks are promising substitutes. Parallel tanning tests have shown that by tanning with a suitable blend of karada bark and Salem myrobalans, E.I. kips of a quality similar to wattle tanned kips are obtained.

5. *Army Retan Leathers* — Leathers meant for army boots and shoes are required to have a thickness of 2-2.5 mm. It is not possible to obtain this thickness from the bulk of Indian cow hides which are thin and of poor substance. Possibility of obtaining the desirable thickness by chrome retanning, in which the hides are first chrome tanned and later on vegetable tanned, have been investigated with positive results. Processes are now being worked out for producing army boot upper leathers by chrome retanning.

6. *Processes for the Manufacture of Different Leathers* — Processes for upholstery leather, fancy leathers, and leather for football cover are being worked out. Work is also in progress on:

- (i) Manufacture of chamois leather, fancy leathers and improved white leather and leather from reptile skins
- (ii) Development of processes for the manufacture of good leathers from bad hides of dead animals of poor substance
- (iii) Development of processes for the use of mineral tanning agents prepared in the laboratory
- (iv) Development of pigment finishes for leather
- (v) Modifications for the existing E.I. tanning processes to reduce cost and time of tanning
- (vi) Semi-chrome tanning
- (vii) Chrome combination tannage
- (viii) Neutralization of chrome tanned leather

Academic Research

Apart from a large number of problems of industrial value a few researches of academic nature are also being pursued on:

1. Constitution of vegetable tannin of avaram bark
2. Mechanism of protein aldehyde tannages
3. **Chrome-vegetable combination tannages**
4. Aluminium tannage and mechanism of mineral tannages
5. Mechanism of neutralization of chrome tanned leather
6. Determination of the constitution of synthetic tannins and the mechanism of their tanning
7. **Chemistry of semi-chrome tanning**
8. Properties of certain indigenous tanning materials and mechanism of vegetable tannage
9. Enzymes in relation to leather manufacture
10. Combining capacity of collagen with salts of weak acids in vegetable tan liquors
11. Collagen solubilizing effects of gallic and pyrogalllic acids of myrobalan liquor

Aid to Industry

The institute maintains close liaison with the tanning industry, both cottage and large scale, to be acquainted with their problems and also to disseminate the results of researches for their adoption and exploitation. A large number of technical enquiries from the industry are received and advice and guidance are given by competent technical staff. Most of the Indian tanners do not have the modern equipment and machinery and many of them do not have even a supply of electricity. The institute machines traders' leathers and improves their finishes to realize better prices. More and more tanners are taking advantage of these facilities offered for which scheduled charges are made.

CENTRAL BUILDING RESEARCH INSTITUTE, ROORKEE

THE Council of Scientific & Industrial Research set up, in December 1943, a Building Research Committee with the late Sardar Teja Singh Malik as Chairman. As an immediate step the Committee proposed the setting up of a Building Research Unit at Roorkee to work in co-operation with the Thomason College of Engineering (now the Engineering University of Roorkee). The Unit consisted of two sections; one of them started research work immediately within the limited facilities available at that time on short-term problems; the other section dealt with the planning of the institute. Meanwhile, at the instance of Dr. S. S. Bhatnagar, the Building Research Committee recommended to the Council the establishment of a Building Research Institute at Roorkee on the lines of other national institutes already set up under the auspices of the Council. This recommendation was accepted by the Council and a suitable site for the institute was acquired and the foundation stone of the new building was laid in February 1951 by the Shri Sri Prakasa, the then Minister for Natural Resources & Scientific Research. The



CENTRAL BUILDING RESEARCH INSTITUTE
ROORKEE

actual construction of the building was taken in hand in December 1951. The full project was completed by April 1953, and the opening ceremony was performed on 12 April 1953.

Scope & Functions

The work of the institute covers four principal groups of problems, viz. (1) building materials; (2) methods of construction; (3) performance of buildings; and (4) survey and information.

The activities of building industry are two-fold in character: (i) development and manufacture of various building materials; and (ii) use of materials in actual construction of buildings. Accordingly, the Building Research Institute concerns itself with production and testing of building materials as well as with construction and testing of structures. These activities call for a team work of chemists, physicists and engineers.

Divisions

The scientific and technical work of the institute is organized in three main Divisions, namely Chemistry, Architectural Physics and Engineering. There are also departments dealing with specific projects of long duration, as distinct from projects which can be treated in any of the three main divisions. Apart from Administration, provision is also made for an Information Service including surveys and statistics, publication and information, library and museum.

Personnel

The staff of the institute consists of a Director, two Assistant Directors, one Senior Scientific Officer, 3 Junior Scientific Officers, an Administrative Officer, 5 Senior Scientific Assistants and 3 Junior Scientific Assistants.

Research Programme

IMMEDIATE PROGRAMME, 1953-54

Material Section

1. Improvement of bricks from black cotton soil
2. Trials on *surkhi* from above types of bricks as puzzolana
3. Further work on bricks from alluvial soils
4. Weathering studies on stones

Cement & Cement Products Section

1. Exfoliation and utilization of Indian vermiculite
2. Utilization of blast furnace slag
3. Studies on puzzolana and puzzolanic cements

4. Manufacture of cheap cement
5. Development of foaming agents
6. Steam curing of concrete

Physics Section

1. Thermal behaviour of buildings and solar paths
2. Designing and assembly of thermal conductivity apparatus
3. Designing and assembly of an apparatus for sonic method of testing concrete
4. Assembly of thermal conductivity probe

Soil Engineering Section

1. Investigations on foundations in black cotton soil
2. Soil survey of areas within a radius of about three miles of Roorkee

Structural Engineering Section

1. Development of concrete-shell structures
2. Improvement of steel bars of single twisting
3. Improvement of hollow tile arch roof

LONG-RANGE RESEARCH

Continuation of work on

1. Bricks
2. Weathering of stones
3. Puzzolanas
4. Foundations in black cotton soil

New Items of Research on Building Materials

1. Light weight clay products
2. Use of bamboo in structural engineering
3. Survey of lime industry
4. Creep of high tensile wire to be used for pre-stressed concrete
5. Testing of paints and varnishes

Pilot plants dealing with

1. Pre-stressed concrete
2. Cold deformation of steel
3. Manufacture of bricks
4. Cement production
5. Vermiculite

Additional Items of Research for Community Projects Administration

1. Production of efficient and economical tiles*
2. Evolving simple, cheap and efficient brick making machines
3. Development of waterproof plaster for an unstabilized Pise and Adobe construction

*These investigations are to start when T.C.A. equipment becomes available and to continue as part of a long-range programme until satisfactory solutions are obtained.

Research Problems Completed & Problems on Hand

1. *Soil Stabilization* — Stabilization of soil with cement is well known. Work carried out in this institute has shown that waste lime sludge from sugar factories and tanneries, mixed with sodium silicate, also stabilizes the soil. This may find use in preparing the base course of light traffic roads or for making building blocks.

Various other substances such as metallic resins, oleates, stearates, lime, alginates, glues and rosin have been tried as waterproofers or integral stabilizers.

2. *Bricks* — The work on bricks and brick clays was taken up in the institute since its inception. Some of the results are given below:

(i) By suitably modifying the mechanical composition of the mix the strength of the brick can be considerably changed, and it is possible to get bricks of high crushing strength of about 7,000 lb./sq. in. as against an ordinary brick which has a strength of 1,500 or 2,000 lb./sq. in. This opens up the possibility of manufacturing special types of stronger bricks suitable for heavy structures at a small extra cost in the manufacture.

(ii) To improve the quality of bricks, Sindri ash was used in production of bricks. Data on the practical experiments are being collected.

3. *Bricks from Black Cotton Soil* — (i) Preliminary trials have shown that in bricks made of black cotton soils of the Poona area, the crushing strength does not change much over a wide range of the firing temperature. Such bricks can be fired at lower temperatures and with fuel of less calorific value or with a lesser quantity of fuel. Large-scale trials are, however, necessary to confirm these findings.

(ii) A method has been developed to manufacture good bricks from black cotton soil with a crushing strength ranging from 3,000 to 5,000 lb./sq. in. Addition of coal ash to the extent of 10-20 per cent to black soils also improves the quality of bricks.

4. *Weathering of Stones* — A systematic study on the weathering quality and physico-chemical properties of a large number of building stones used in the country is being conducted.

5. *Puzzolanas* — Preliminary trials with boiler ash from Sindri Fertilizer Factory have shown that there are distinct possibilities of utilizing this waste product as a puzzolanic material to make puzzolanic cement.

6. *Vermiculite* — The effect of temperature, time and size of particles on the exfoliation of Mysore vermiculite was determined. Cold exfoliation with oxidizing agents such as hydrogen peroxide, ammonium persulphate, etc., was tried. A furnace in which the material can be exposed and the required heat treatment given with sufficient accuracy is being designed. A method for measuring the extent of exfoliation has been developed.

WORK ON LOW COST HOUSING

1. *Construction of Prototypes* — (i) A mud hut was constructed on the usual village lines. The walls were given a special plaster suggested by the Harcourt Butler Technological Institute. Within a few days of plastering, white ants had attacked the hut up to the wooden roof. Later, a hut with rammed earth walls was constructed with clay tile roofing but this cracked badly and was not found satisfactory.

Another model structure was erected to show the use of clay roofing tiles laid over sawn timber framework and a stabilized soil cement floor was provided; after 2-3 years of weathering, the roof gave way.

(ii) A number of panels constructed of cement-stabilized soil blocks and ordinary sun dried bricks, and with different plasters and renderings were subjected to weathering for the last two seasons. On the whole the stabilized blocks are behaving well. *Surkhi* lime plaster on panels of sun dried bricks has been found successful. Cement wash has also been found satisfactory.

2. *Thermal Behaviour of Buildings* — (i) Preliminary work has been carried out to study the thermal behaviour of some of the residential staff quarters. The results indicate the importance of proper orientation of buildings to achieve maximum thermal comfort.

(ii) Solar charts for use by architects and designers have been prepared for some typical regions of the country, viz. Bombay, Hyderabad, Lucknow, Madras, Delhi and Calcutta.

3. *Reviews & Summaries* — (i) A number of notes on different topics were written at the request of the expert Committee on Scientific Low Cost Housing for its use and to assist the committee in the study of the housing problem on a regional basis.

(ii) A review of the available information on foam concrete has been published.

Surveys

The following surveys were conducted and the reports will be published shortly in the form of bulletins:

1. Low cost housing in India today
2. Village housing in India in the States of Bombay, Punjab, Madras and Uttar Pradesh
3. Present position of brick manufacture in India

Practical Projects

1. *C.B.R.I. Shell Houses* — A few prototype structures which illustrate the application of corrugated concrete shells in house construction have been put up. On one of these, the method of construction is shown stage by stage. In another unit, the house is shown entirely finished with partitions, doors, windows, lining and painting. The house is 20 ft. wide and 23 ft. 6 in. long, with a floor area of 470 sq. ft. The quantities of material required to construct the foundations, floors, walls and roof of one house are 2.8 tons of cement, 13 cu. yd. of aggregate and 140 sq. yd. of jute hessian. The cost quoted by contractors for the structural portion only, i.e. foundations, floors, walls and roof, works out to Rs. 1.12/- per sq. ft. of covered floor area, when production is on a large scale. This type of shell house is suited for equitable climates, e.g. in areas near Bombay and Calcutta. For hot arid tracts such as Delhi, a double shell roof is necessary which increases the cost of construction from Rs. 1.12/- to Rs. 2.8/- per sq. ft. of covered floor area.

2. *Light-duty Floors* — A light-duty floor, introducing a non-conventional technique, has been used in the above shell house. It consists of

a 1 in. layer of concrete placed on stretched jute hessian over concrete plunger piles, 2 ft. 6 in. long at 3 ft. centres both ways. The loose earth supporting the jute hessian during the construction of the floor settles after a few weeks, and an insulating air gap is formed. Due to this, the floor is cool in summer and warm in winter. Live and dead loads of the floor are entirely carried by the piles. The cost of such a floor is Rs. 34/- per 100 sq. ft.

3. *Twin-twisted Steel Bars* — Another non-conventional type of production process already known in Europe and America has been introduced, viz. twin-twisting of steel bars for improving the strength and other qualities of reinforcing steel by twin-twisting two steel bars into one stranded unit. By this cold deformation, the yield strength of the ordinary mild steel is raised by 50 per cent. In other words two tons of the twin-twisted steel do the work of three tons of ordinary mild steel. A saving of one-third of steel used in reinforced concrete can thus be effected.

A capital expenditure of approximately Rs. 50,000 is usually required for the plant producing twin-twisted bars but introducing a radical simplification, the institute has put up a small pilot plant of simple equipment for a cost of less than Rs. 2,000. This opens up the possibility of making twin-twisted bars with small capital expenditure so that this process could be used on all major construction jobs.

4. *Pre-stressed Concrete* — The principal advantages of pre-stressed concrete as compared with reinforced concrete are: saving in steel up to 85 per cent; saving in concrete and consequently in cement up to 50 per cent; improved load-carrying capacity within the working range; better performance with regard to weather resistance; pre-stressed concrete is elastic while reinforced concrete is brittle; and structures in pre-stressed concrete are more slender and, therefore, more elegant than similar structures in reinforced concrete.

A few pre-stressed concrete structures have already been erected in this country. It is proposed to establish a pilot plant to produce a wide range of precast products and give advice on equipment required, method of production and other technical matters to manufacturers.

Aid to Industry

Testing of concretes, stones, soils, gypsum blocks, sand-lime bricks, and many other conventional and modern building materials has been carried out for Government and non-government organizations.

A short descriptive pamphlet giving the main features and constructional details of shell houses has been supplied in reply to a large number of enquiries.

Help has also been given in the formulation of standards to the Indian Standards Institution. The institute is represented on the Engineering Division of the Indian Standards Institution and its subcommittees.

A large number of enquiries from the public sector are also being dealt with.

CENTRAL SALT RESEARCH STATION, BHAVNAGAR

THE Salt Research Committee of the Council received a proposal from the Ministry of Works, Production & Supply for the establishment of a national laboratory for carrying out research work on salt, which would also deal with the problems concerning marine salt, salt from salt lakes and subsoil brine, and mine salt. The Ministry also offered to finance the expenditure on this laboratory from the development cess collected on salt. This proposal was considered and approved by the Salt Research Committee at its meeting held on 27 October 1951. The original offer of the Salt Commissioner of a building for housing this laboratory at Sambhar did not materialize. Later on the Saurashtra Government made a generous offer of a suitable building at Bhavnagar. The Central Salt Research Station is housed in the old Raj Hotel Building at Bhavnagar, a gift of the Saurashtra Government.

Additions and alterations to the building, provision of services, gas, water and electricity and equipment of the laboratory are in progress. The Saurashtra Government has also made a gift of 125 acres of land near the Concrete Jetty for establishment of a Salt Farm and a Field Experiment Station.

The main functions of the Central Salt Research Station will be:

1. To devise methods for economically improving the quality of sea and lake brine salt
2. To investigate the recovery and utilization of byproducts

The work of the laboratory is for the present to be carried out in three divisions:

1. Division of Analytical Chemistry
2. Division of Physical Chemistry
3. Division of Inorganic Chemistry

A Director with a nucleus staff is planning and organizing the station.

NATIONAL BOTANICAL GARDEN, LUCKNOW

IN July 1952, the Honorary Director, Sikander Bagh, Lucknow, submitted a proposal to the Council of Scientific & Industrial Research that the Sikander Bagh Gardens should be taken over from the U.P. Government and developed as a centrally administered garden.

The U.P. Government agreed to the proposal and the scheme was approved by the Governing Body of the Council in March 1953. The Council of Scientific & Industrial Research took charge of the Sikander Bagh, Lucknow, from U.P. Government on 1 May 1953 and named it as the National Botanical Garden. It was considered that a botanical garden with a well-equipped herbarium would be a great asset in the development of drug research which has already been organized in Lucknow at the Central Drug Research Institute.



CENTRAL SALT RESEARCH STATION
BHAVNAGAR

Scope & Functions

The scope and functions of the National Botanical Garden include:

1. Botanical research including plant breeding, developing new varieties of economic importance and horticultural research
2. Research on cultivation of medicinal, fibre yielding and essential oil-bearing plants
3. Maintenance of a national herbarium particularly for collection and preservation of rare species of plants of economic and scientific interest
4. Maintenance of an arboretum
5. Maintenance of a museum
6. Training of botanists and horticulturists
7. Supply and exchange of plants within the country and outside

Division of Work — The work of the institution may be split into sections dealing with:

1. Garden
2. Research (Botany and Horticulture)
3. Herbarium
4. Museum
5. Administration
6. Intelligence, Library and Information
7. Stores

Personnel

The present staff consists of a Director, a Senior Scientific Officer and a Junior Scientific Officer besides others.

The present activities of the garden may be grouped under the following heads:

1. Herbarium
2. The Horticulture Laboratory
3. Research in cultivation of medicinal plants
4. Maintenance of the garden as a place of recreation and education of botany students
5. Library

The Garden

Pre-shaping of the garden on modern lines is being planned. Green-houses and artificial lakes are under construction and a rosarium is being organized.

Graft varieties of mango, guava, amla and gutties of different varieties of citrus were raised. Several varieties of bananas and pine-apples were introduced. Seedlings of vegetable plants were raised from improved seeds. A separate botanical section is maintained for display of representative plants of different families to students of educational institutions.

The Herbarium

A nucleus of a herbarium has been organized with specimens representing all plant groups. Of these, the largest in number are flowering plants totalling more than 10,000, including Indian plants and plants obtained from abroad. Of these, nearly 5,000 specimens are authentically identified according to Bentham and Hooker's classification and systematically lodged. Recently, as a result of a survey of North-western Himalayas in Kashmir, a large number of plants were collected for the herbarium and for the garden. District-wise botanical survey has been started in Uttar Pradesh. A systematic catalogue of the material in the herbarium is under preparation.

The Horticulture Laboratory

A horticulture laboratory has been organized and the following problems are under investigation:

1. Application of hormones in horticulture with particular reference to rootage, prevention of pre-harvest fruit drop and parthenocarp
2. Studies on nutritional requirements of fruit trees
3. Growth, flowering and fruiting behaviour of fruit trees
4. Improvement of some major fruit plants of U.P.
5. Vernalization and photo-periodic induction in some horticultural crops
6. Morphological and cytogenetical studies in the family *Cucurbitaceae*; a scheme sponsored by the U.P. Research Committee; a large variety of melons has been collected and sown in the village of Mirzapur, 5 miles from Lucknow, under ordinary village conditions

Cultivation of Medicinal Plants

Over 500 species of medicinal plants are being grown in nursery plots. *Plantago ovata*, *Athaea rosea*, *Cichorium intybus*, *Calendula* and *Piper longum* have been cultivated on a large scale. A method of quick multiplication of the drug plant *Rauwolfia serpentina* has been developed and it is proposed to grow this plant extensively.

Library

Books, numbering 1,200, on important flora, have been collected. It is proposed to enrich the library with periodicals, rare books on the Unani and Ayurvedic systems of medicine, different branches of botanical science including geographical survey works.

Plans for the construction of a botanical laboratory, a herbarium, a library and a museum are under consideration.



ENTRANCE TO THE NATIONAL BOTANICAL GARDEN
LUCKNOW

CENTRAL ELECTRONICS ENGINEERING INSTITUTE PILANI

THE proposal to start a national institute for electronics was sponsored by Dr. S. S. Bhatnagar who was successful in persuading Shri G. D. Birla, in October 1950, to give a handsome donation of Rs. 21 lakhs for the purpose of establishing a research institute at Pilani. This offer was considered by the Governing Body of the Council at its meeting held on 14 March 1951, and they appointed a committee to report on the establishment of the institute. Dr. S. S. Bhatnagar visited Pilani in February 1951 and inspected the site earmarked for the institute and examined the educational and other facilities available. The committee accepted Dr. Bhatnagar's recommendation that the institute should be located at Pilani. A plan for the proposed institute was considered. The committee recommended, in the first stage, a capital expenditure of Rs. 25 lakhs on buildings and equipment and an annual recurring expenditure of Rs. 5 lakhs. The Birla Education Trust has offered to give Rs. 50,000 per annum towards the recurring expenditure. The Governing Body of the Council accepted the recommendations of the Committee. A Local Planning Committee, with the Director, Scientific & Industrial Research, as Chairman, and the Planning Officer as Secretary, has been constituted to draw up plans and estimates for the institute. The foundation-stone of the institute was laid by Shri Jawaharlal Nehru on 21 September 1953.

The main object of the institute is to undertake research and development on all aspects of electronics engineering. Its scope and functions include: (1) research on utilization of indigenous raw materials; (2) to study pilot plant production of components; (3) development and use of electronic circuits to improve the efficiency of indigenous industries; (4) to build standard electronic instruments for tests; (5) to develop special radio circuits; (6) to develop electronic apparatus for the medical profession; (7) to conduct experiments on communications, radar and other equipment; (8) to develop and build acoustic equipment and instruments; and (9) to utilize electronics for industrial purposes.

The work of the institute will be divided to deal with (1) Electronic Circuits, (2) Electronic Components, (3) Electronic Instruments, (4) Electro-acoustics and Audio-engineering, and (5) Ultra-high Frequency and Microwave Equipment.

V

SPONSORED RESEARCH

THE Board of Scientific & Industrial Research advises the Council in its work relating to "the promotion, guidance and co-ordination of scientific and industrial research in India, including the institution and the financing of specific researches". The Board, which was set up in 1940 by the Government of India as successor to the Industrial Research Bureau, now functions as an Advisory Body to the Council. The functions assigned to it at the time of its inception were: "to survey the work that is being done in the existing organizations, invite proposals from all sources, initiate discussions and make recommendations to the Government of India, who will prescribe from time to time the general lines on which research should be undertaken and pursued. The Board will also report to the Government of India what specific problems should in its opinion be assigned for investigation to the staff directly under the Board on the one hand and to the various scientific research institutions in the country, including the university laboratories, on the other." The Board was tendering advice directly to the Government till 1942, and when the Council of Scientific & Industrial Research was established, the Board was constituted as an Advisory Body to the Council, its functions remaining unchanged.

Constitution -- The Prime Minister is the President of the Board of Scientific & Industrial Research and the Minister for Natural Resources & Scientific Research is its Vice-President. The present Board of 17 members, which was constituted on 1 April 1953, consists of scientists from universities, research institutions and Government departments, and prominent industrialists. Expert Research Committees for different subjects have been set up by the Board. There are at present 25 Research Committees. Subcommittees are constituted from time to time for examining special problems. Mention may be made of Subcommittees for Coal Blending & Coking; Microseisms, Sea Waves & Swells; Calendar Reform; Power Alcohol from Bagasse; Synthetic Petrol; and Low Cost Housing.

During the period 1940-45, the activities of the Board and its research committees were directed mainly to the mobilization of facilities and personnel available in universities and research institutions for the solution of urgent problems connected with the war effort. The experience gained during this period was valuable for assessing the needs of science and industry and for the formulation of post-war programmes of research and its application to practical problems. After the termination of the war, the Board of Scientific & Industrial Research applied itself resolutely to the twin problems of fostering increased research, pure and applied, and the supply and training of research personnel. In both these the Board has achieved substantial results.

Research Committees -- The functions of the research committees are: (1) to advise on matters pertaining to scientific and industrial research in their respective fields; (2) to survey the work done, facilities and personnel available at different centres and to formulate a planned programme of

research for the advancement of knowledge and its application; and (3) to initiate research and recommend grants for research schemes, watch their progress and co-ordinate them.

The research committees meet twice a year to survey the progress of work under the schemes sponsored by them, consider new research projects and formulate proposals for the consideration of the Board of Scientific & Industrial Research. The committees also sponsor surveys and recommend the establishment of new institutions or the creation of additional facilities for specific fields of research. In several cases, universities have been assisted in organizing and maintaining special departments by means of block grants. They also recommend specific subjects for investigation to other organizations and Government departments. The committees arrange symposia and joint consultations with other scientific organizations for facilitating exchange of views and for effecting collaboration and co-ordination of work. The research committees ensure that research effort is directed according to a planned programme, that border-line subjects receive adequate attention and that duplication of work is avoided.

Schemes of research submitted for financial assistance are examined by research committees on their merit. Programmes of research drawn up by research committees are circulated to university departments and research institutions. Vexatious restrictions on objectives, time schedules or methods are not imposed and investigators are free to pursue investigations in a manner which they consider appropriate for obtaining results. Investigators are free to select their scientific assistants, obtain the equipment required, and incur contingent expenditure according to needs within certain broad principles laid down by the Council. Permission to publish the results or to include them in theses, which the investigators wish to submit for improving their academic qualifications, is readily granted, provided the results are not of a patentable character.

Schemes of research have been sponsored also in technological institutions and Government establishments and, in some instances, research workers unattached to any institution have received encouragement to pursue investigations. In some cases, research projects from industrial works laboratories have been supported as results achieved in such laboratories are likely to be immediately utilized by the industries concerned.

Training of Research Personnel — Sponsored research under the grants-in-aid scheme has been particularly fruitful in the training of research personnel. A large number of research schemes are being investigated in university laboratories, and several schools of research, providing opportunities for the postgraduate training of students with promising academic records, have been developed. Many students have obtained their doctorates and master of science degrees by working under the guidance of senior scientists in charge of the schemes.

To ensure that sponsored research is not concentrated in a limited number of research centres or restricted to a few leading scientists, it has been specified that not more than three research schemes should be approved for being directed by one chief investigator, however eminent he may be. This restriction provides opportunities to junior workers in a large number of centres to pursue research and eventually to become leaders of research teams.

The number of research schemes sponsored by the Council, the number of centres in which investigations are being pursued, and the grants

annually made towards sponsored research during the period 1942-53 are given in Table 1.

TABLE 1—SPONSORED RESEARCH

YEAR	NO. OF SCHEMES	NO. OF CENTRES	TOTAL GRANT (Rs.)
1942-43	71	18	2,90,896
1943-44	73	24	5,25,327
1944-45	64	26	4,88,439
1945-46	111	36	7,83,508
1946-47	116	30	8,39,815
1947-48	115	29	14,17,732
1948-49	120	38	11,70,877
1949-50	148	36	9,56,404
1950-51	85	39	8,79,939
1951-52	93	49	7,93,856
1952-53	110	57	8,18,129

The nature and scope of the activities of the 25 research committees are briefly described in the following pages. A brief account of the work of special committees and *ad hoc* committees is also given. A list of the schemes sponsored by the Council is given in Appendix II. Besides recommending research schemes, the committees have initiated a large number of surveys on natural resources and raw materials for specific industries, and explored the possibilities for the production of industrial products which are at present imported. The results of such surveys are published in several monographs, bulletins and reports. The results obtained under the research schemes sponsored by the committees have been incorporated in 556 original papers published in Indian and foreign periodicals, and form valuable contributions to knowledge. Besides, 126 patents have been taken out. The grants-in-aid scheme has stimulated research in a large number of centres, expanded research facilities and provided opportunities for the training of research personnel.

RESEARCH COMMITTEES

Statistics, Standards & Quality Control Committee

THE Committee on Statistics, Standards & Quality Control was set up in 1944 with Prof. P. C. Mahalanobis as chairman. The committee decided to concentrate its activities in the first instance on work connected with standards and statistical quality control with special reference to Indian industries. The scope of the committee may be extended later to include the study of the human factor in industry, statistical aspects of cost accounting and application of statistical methods generally for improving the efficiency of industrial production.

The committee has been taking advantage of visiting experts in statistics and has had discussions with them on the training of statisticians

and the application of statistical quality control in Indian industries. Prominent among the visiting statisticians with whom the committee had arranged discussions are Prof. R. A. Fisher of the University of Cambridge, Dr. A. W. Swan of the *United Steel Company*, Sheffield, Prof. R. Ott of the Rutgers University, U.S.A., and members of the Statistical Quality Control (S.Q.C.) team of the United Nations Technical Assistance Administration.

RECOMMENDATIONS

At the first meeting of the committee held in December 1944, the committee strongly recommended the proposal for setting up a Central Standards Organization for India. Later, the Government of India set up the Indian Standards Institution under the auspices of the Ministry of Commerce & Industry.

In view of the lack of trained statisticians in the country, the committee made a recommendation to the Inter-universities Board for introducing statistics as a subject in Indian universities.

The committee associated itself with the work of the U.N. team of experts which visited India towards the end of 1952 and conducted training courses in quality control at Delhi, Bombay, Calcutta and Madras. The committee had detailed discussions with the experts with regard to the follow-up programme of training in India. A Statistical Quality Control Unit has been set up in the Indian Statistical Institute at Calcutta.

RESEARCH & TRAINING

Statistical Research & Training in India—A survey of the activities of centres imparting training in statistics and statistical quality control was undertaken by the committee with a view to assessing the nature of work done and the facilities available at these centres. The survey revealed the existence of nine active centres for training in statistics.

Training Course at the Indian Statistical Institute, Calcutta—A one-year course of training in industrial statistics was held in 1945-46. Training was imparted in both theoretical and practical statistics. Ten students were awarded certificates at the end of the course.

Training & Research in Statistical Quality Control (S.Q.C.)—Since 1950, the Council has been making an annual block grant to the Bombay Branch of the Indian Statistical Institute for training and research in quality control. So far five courses of training, each of about 14 weeks' duration, have been organized with 30-40 trainees from industries in Bombay attending each of these courses. To begin with, the training was directed to S.Q.C. in the textile industry. It is gratifying to note that some of the mills in Bombay have appreciated the benefits of statistical quality control and appointed their own staff of S.Q.C. investigators. *Messrs Seksaria Mills, Shriniwas Mills, Victoria Mills and Madhusudan Mills* are taking considerable interest in S.Q.C. and the *Firestone Tyre & Rubber Company* have started a S.Q.C. department of their own.

Application of Quality Control Methods—Field work in the application of quality control methods has been undertaken in a few selected industries in Bombay. Investigations were undertaken in the blow room and in the ring spinning and roving departments of textile mills to study

(i) variations between laps and (ii) variations within laps. By using appropriate control charts the causes for the variations were found out and suggestions were made for overcoming these difficulties. In ring spinning and roving, yarn breaks were recorded for periods of 15 min. and 30 min. The factors which were responsible for the breakages were investigated and advice was given to the mills.

Similar studies were undertaken in the Government Control Press, Bombay, and suggestions were made for improving the operations in the Mono and Lino sections and for increasing the out-turn of casting and printing machines.

A Quality Control Study Group, comprising of local trainees of the United Nations Training Course and trainees of the Bombay Branch, has been constituted for facilitating discussions on quality control problems, co-ordinating the work of members and fostering interest in statistical quality control.

Statistical Quality Control Unit — At a meeting of the Council held in September 1953, a subcommittee was constituted to discuss with Prof. P. C. Mahalanobis the details of his proposal for setting up a Statistical Quality Control Unit at Calcutta. On the recommendation of the subcommittee, the Council has now agreed to make a block grant of Rs. 10,000 per year to this unit. The unit, which would consist of 3 or 4 whole-time statisticians with S.Q.C. experience, will follow up the work of the S.Q.C. team of the United Nations Technical Assistance Administration. The unit will also provide training in S.Q.C. and apply S.Q.C. methods in selected industries.

The number of schemes sponsored by the committee is four. Four papers have been published.

Physical Research Committee

THE Scientific Instruments Committee was constituted in July 1940 under the chairmanship of Prof. M. N. Saha. The committee was bifurcated in 1942 into (i) the Optical Instruments Committee (Chairman, Dr. Nazir Ahmed) and (ii) the Applied Physical Instruments Committee (Chairman, Prof. M. N. Saha). They were merged again in 1943 into the Applied Physics Research Committee. The committee was reconstituted in 1950 under the name Physical Research Committee and its scope enlarged to cover both fundamental and applied research.

SCIENTIFIC INSTRUMENTS INDUSTRY

A subcommittee was appointed in 1944 to make a survey of the scientific instruments industry in India. The subcommittee made the following recommendations:

1. Steps should be taken to make available the important raw materials and component parts required for the manufacture of scientific instruments such as (i) optical glass, (ii) special alloys for tools, springs, magnets, and resistant materials; (iii) synthetic resins and ebonite; (iv) tubes of brass and other metals; (v) abrasives and grinding materials; (vi) adhesives and cementing materials; (vii) wires and strips; (viii) paints, varnishes and enamels; (ix) insulating materials; (x) bearings (ball-bearings, jewel bearings, etc.), and (xi) clock works and gear trains.

2. Steps should be taken for training suitable personnel and skilled labour required for manning the industry.

3. Standardization of scientific instruments should form part of the work of the National Physical Laboratory of India and a museum for displaying the standardized instruments should be maintained.

The recommendations were accepted by the Council and, as the production of scientific instruments came under the jurisdiction of the Scientific Instruments Panel of the then Planning and Development Department of the Government of India, the views of the subcommittee were placed before them.

PRODUCTION OF DIAMOND DIES

The Indian Tariff Board, while granting protection to the silver thread and wire thread industry in India, recommended that the Council of Scientific & Industrial Research should take up investigations with a view to developing indigenous production of diamond dies to replace the use of ruby dies.

The position of the jari industry was surveyed by Dr. George Sachs, then Director of the National Metallurgical Laboratory. He visited the chief manufacturing centres at Banaras and Surat and submitted a report incorporating suggestions for the improvement of wire drawing dies. The committee considered the report and recommended that work on diamond dies should be undertaken at the National Physical Laboratory of India and a person should be trained in the manufacture of diamond dies in U.S.A.

INTERNATIONAL BODIES

The advice of the committee is sought in connection with the work of the following international bodies of which India is a member: (i) International Union of Crystallography; (ii) International Union of Theoretical & Applied Mechanics; and (iii) International Union of Pure & Applied Physics.

Efforts have been directed by the Physical Research Committee to the development of instruments.

Sponsored research carried out by Mr. Athavale has established the manufacture of thermocouple type R.F. ammeters (0-500 m. amp., 0-1, 0-2.5 and 0-5 amp.) in India, whose requirements of these instruments can now be met by Indian manufacture.

The total number of research schemes sponsored by the committee is 41.

Researches under the following 13 schemes are in progress:

1. Investigations on molecular spectra — DR. R. K. ASUNDI, Banaras Hindu University, Banaras
2. Designing and development of electrical measuring instruments — MR. N. M. ATHAVALA, Poona
3. X-ray diffraction studies of crystals — PROF. K. BANERJEE, Allahabad University, Allahabad
4. Use of photo-multiplier tubes in the measurement of feeble X-ray intensity — PROF. K. BANERJEE, Allahabad University, Allahabad

5. Study of X-ray emission and absorption spectra in the region 1-8 to 10A — DR. G. B. DEODHAR, Allahabad University, Allahabad
 6. Electron diffraction studies on semi-conductor rectifiers and development of copper oxide triode — DR. K. R. DIXIT, Institute of Science, Bombay
 7. Single crystals of alumina and other refractory materials — DR. P. K. KICHLU, Delhi University, Delhi
 8. Ruling engine for diffraction gratings — DR. P. K. KICHLU, Delhi University, Delhi
 9. Molecular spectra in visible and ultra-violet regions — DR. K. MAJUMDAR, Allahabad University, Allahabad
 10. Fluorescence and absorption spectra of organic molecules — DR. V. RAMAKRISHNA RAO, Andhra University, Waltair
 11. Study of absorption and dielectric properties in the microwave region — DR. P. N. SHARMA, Lucknow University, Lucknow
 12. Thermal diffusion and inter-diffusion of gases — DR. B. N. SRIVASTAVA, Indian Association for the Cultivation of Science, Calcutta
 13. Spectral studies of heterocyclic aromatic compounds — DR. M. R. PADHYE, Bombay University, Bombay
- Fifty-one research papers have been published.

Radio Research Committee

PRIOR to the setting up of the Radio Research Committee in 1942, problems on radio research were being considered by the Instruments Committee of the Council. In 1942, the Council decided to establish the Radio Research Committee and assigned the following functions to it:

(1) To discuss and formulate plans of research as under: (a) investigation of problems of immediate practical importance for the development of radio industry in India on a sound basis; (b) synoptic studies of atmospheric phenomena as affecting radio wave propagation, e.g. atmospherics, ionosphere, etc.; and (c) investigations of a fundamental nature as may have long-range application to radio development;

(2) to maintain a list of the institutions in India where radio researches are being carried on and to keep record of their activities and available facilities;

(3) to distribute the problems decided upon to such institutions as are capable of and are willing to co-operate with the work of the committee and to generally see that there is no duplication of work; and

(4) to arrange for testing and standardization of radio products.

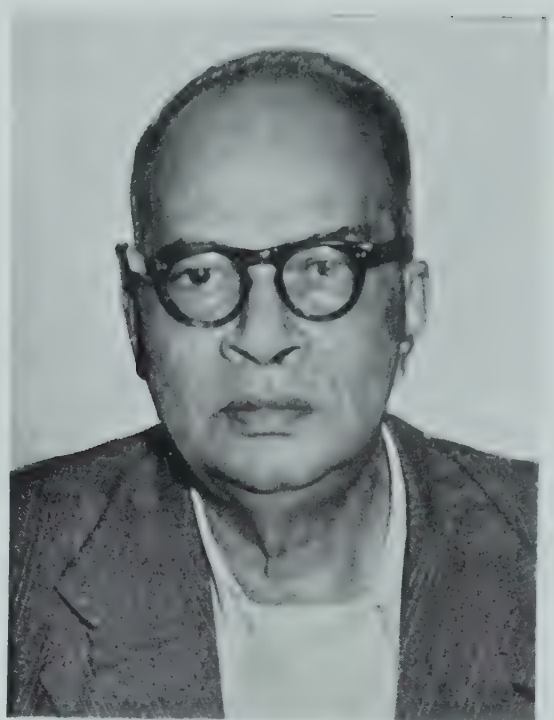
Prof. S. K. Mitra was the first chairman of the committee. He was succeeded by Prof. M. N. Saha in 1948. Since 1950, Dr. K. S. Krishnan is the chairman of the committee.

The Radio Research Committee has been instrumental in the establishment of schools of research at the Calcutta University, the Banaras Hindu University, the Andhra University, the Allahabad University, and at the Physical Research Laboratory, Ahmedabad. The committee has initiated surveys on subjects of theoretical and practical importance. It has stimulated researches on the ionosphere, atmospherics and microwaves and contributed materially to the progress of the radio components manufacturing industry.

PAST PRESIDENTS, C.S.I.R.



DR. A. RAMASWAMI MUDALIAR
(1942)



SHRI N. R. SARKAR
(1942-43)



SHRI N. R. PILLAI
(1943)



SHRI MOHAMMAD AZIZUL HAQUE
(1943-44)

The committee has taken interest in the promotion of training facilities in radar and telecommunication, and assisted the Education Ministry in framing the syllabus for telecommunication engineering in universities. It has drawn the attention of universities to the importance of introducing courses of study in high-frequency and microwave techniques at the postgraduate level.

The committee provides information to research workers on the availability of research equipment and helps them to obtain equipment required for their work.

CO-OPERATION WITH INTERNATIONAL ORGANIZATIONS

The Radio Research Committee has been recognized by the Government of India as the National Committee for the International Scientific Radio Union (U.R.S.I.). The functions of the National Committee are: (1) to promote and organize researches requiring international co-operation and the scientific discussion and publication of these researches; and (2) to promote the setting up of common methods of measurement as well as the intercomparison and standardization of the measuring instruments used in scientific work.

As the National Committee in India for the U.R.S.I., the Radio Research Committee has to implement the recommendations of the following seven commissions of the Union: (i) Measurements and Standardization; (ii) Troposphere and Propagation; (iii) Ionosphere and Wave Propagation; (iv) Terrestrial Atmospherics; (v) Extra-terrestrial Radio Noise; (vi) Waves and Oscillations; and (vii) Electronics.

On the recommendation of the U.R.S.I., the committee considered the question of maintaining and broadcasting standards of time, tone and frequency, and recommended that this work should be undertaken by the National Physical Laboratory of India.

The proposal for organizing the Third International Geophysical Year (1957-58), received from the International Council of Scientific Unions, was considered by the Radio Research Committee. A National Committee, which includes representatives of the Survey of India, the Central Board of Geophysics and the India Meteorological Department, has been constituted for implementing the programme of work of the International Council.

Dr. K. S. Krishnan, Chairman of the Radio Research Committee, and Mr. A. P. Mitra attended the Tenth General Assembly of the U.R.S.I. in Australia in August 1952 as official delegates of India.

PROGRAMME OF WORK

A subcommittee was appointed in 1953 to prepare a planned programme of work for the Radio Research Committee. The preliminary recommendations of the subcommittee are: (1) the programme of work outlined by the U.R.S.I. and the British Commonwealth Conference on Radio Research held in 1952 should be implemented as far as possible; (2) the programme of work planned by the Third International Geophysical Year Committee should also be implemented; and (3) arrangements to be made to implement the recommendations contained in the Report of the Inter-

national Consultative Committee on Radio which would be of interest to the Indian National Committee.

SURVEYS & REPORTS

The committee has prepared reports on several subjects. The more important ones are listed below:

1. Report on the position of radio industry in India
2. Report on facilities for testing and standardization of radio equipment and components
3. Plan for a Central Radio & Electronics Research Laboratory
4. Bibliography on atmospherics
5. Bibliography on radar
6. Survey of work done in atmospherics in India
7. Survey of facilities for teaching and training in radio in India
8. Some fundamental research problems in ultra-short waves and microwaves
9. Some recent advances in radio physics and electronics
10. Survey of ionospheric research activities in India and suggestions for their co-ordination
11. Survey of production of insulating materials and dielectrics for high-frequency work
12. Possibilities of manufacture of radio components
13. List of raw materials used in radio industry

IONOSPHERIC RESEARCH

The committee has participated in the world programme of studies on the ionosphere since 1943 utilizing the facilities then existing in the University of Calcutta. Since the data collected were found useful, especially during the war, regular 24-hour observations are being maintained. The committee has established an Ionospheric Research Station at Haringhata, 24 miles from Calcutta. The data collected are published every month in the *Journal of Scientific & Industrial Research* and cyclo-styled copies of the same are sent to ionospheric laboratories all over the world.

In recognition of the value of ionospheric investigations carried out at the Calcutta University, the Commonwealth Scientific & Industrial Research Organization, Australia, has presented to the University of Calcutta, on permanent loan, an automatic ionospheric recorder.

The question of co-ordinating research work on ionosphere carried out in different laboratories and the desirability of analysing and publishing ionospheric data by a single agency was considered by the committee in 1951. A subcommittee was appointed to review the synoptic studies carried out by the All India Radio, the Meteorological Department, and universities and research institutions in India.

The subcommittee has drawn the attention of stations, where routine observations are being carried out, to the desirability of conforming to the standard schedule of observations and of adopting the terminology

for reporting the data as laid down by the U.R.S.I. The Radio Research Committee will soon undertake the compilation, analysis and publication of ionospheric data in a co-ordinated form.

RESEARCH ON ATMOSPHERICS

A subcommittee was set up in 1942 to formulate plans for research on atmospherics. The committee examined the question of organizing systematic research on the subject at different centres in India and recommended that systematic observations on the direction and form of atmospherics with particular reference to locating disturbance centres, such as storm centres in Indian seas, should be undertaken. Five stations were set up at Bangalore, Dacca, Delhi, Poona and Waltair to make routine observations in collaboration with the observatories of the India Meteorological Department at these centres, and also to make measurements of the intensities of atmospherics. The data collected were analysed and published by the committee. The data were of immediate importance in connection with weather forecasting during the war years. The committee has made useful and constructive suggestions with regard to the construction and standardization of recording instruments.

ULTRA-SHORT WAVES & MICROWAVES

In view of the importance of research on ultra-short waves and microwaves and the increasing application of ultra-short and microwaves in radar and radio relay systems and safety aids in sea and aerial navigation, the Radio Research Committee set up an Ultra-short Wave and Microwave Panel in 1946 to initiate work on the following: (1) development of microwave generators; (2) development of wave guides and radios; (3) crystal detectors; (4) microwave measuring techniques; (5) interaction of microwaves with matter; (6) application of microwaves to meteorology; (7) radar; and (8) servo-mechanism.

In order to collect the information on the above subjects and also to suggest fruitful lines of research, seventeen study groups were formed and the findings of the study groups were discussed at a symposium held at Delhi in December 1949. As a result of the discussions, the committee recommended that (i) research on radio astronomy (solar and galactic noise) and (ii) study of semi-conductors at microwave frequencies should be started. The committee also recommended that the Council of Scientific & Industrial Research should draw the attention of universities to the importance of introducing courses of study on high-frequency and microwave techniques.

RESEARCH & TRAINING IN RADAR

A survey of the facilities obtaining in various institutions for practical training and research in radio and electronics was made in 1949. The committee found that the facilities available were inadequate and recommended that the training courses should be standardized and improved. The Ministry of Education took the assistance of the committee in the formulation of a model syllabus for telecommunication engineering.

Recognizing the importance of practical training in radar and microwave techniques, a short training course in radar for civilian scientists has been organized by the Ministry of Defence at the instance of the committee. Two batches of radar scientists have received practical training in microwave technique at the I.C.M.E. establishment at Agra and at the I.A.F. Radar Centre at Jalahalli, Bangalore.

DEVELOPMENT OF RADIO INDUSTRY

The Radio Research Committee surveyed the position of the radio industry in India and prepared a report on the manufacture of radio receivers. The starting of a national radio industry was also considered and the committee recommended that the Government should help industrialists in establishing radio factories by providing tariff protection.

A survey of the existing facilities for testing and standardization of radio equipment and components was carried out by the committee in 1945. The survey revealed that though some facilities were available in certain institutions, the equipment employed for testing and standardization was far below the standard. The committee suggested the establishment of a Central Radio Research Laboratory for testing and standardization of radio equipment. A plan for such a laboratory was drawn up by the committee and submitted to the Board of Scientific & Industrial Research.

At a joint meeting of the Radio Research Committee and the Wireless Industry Project Subcommittee of the Director General of Industry & Supply, held in July 1948, it was decided to set up a State-owned wireless factory. For working out the details relating to the establishment of the factory, an expert committee was appointed. The efforts of this committee have resulted in the establishment of the *Bharat Electronics Industries* at Bangalore under the Ministry of Defence.

On the recommendations of the committee, the National Physical Laboratory of India has undertaken development work relating to the following radio components: (a) silver mica capacitors; (b) high-frequency ceramics; (c) high dielectric titania; (d) electrolytic capacitors; (e) volume controls; (f) cracked film resistors; and (g) glass for radio valves.

The Radio Research Committee has recently appointed a Subcommittee on Raw Materials to consider the question of developing indigenous raw materials for the radio industry. The subcommittee has drawn up a list which is now receiving the consideration of the Council.

The total number of research schemes sponsored by the committee is 27.

The following schemes are under investigation:

1. Travelling wave disturbances in the ionosphere by spaced receiver method — DR. B. RAMACHANDRA RAO, Andhra University, Waltair
2. Development of microwave technique and its applications — DR. K. RANGADHAMA RAO, Andhra University, Waltair
3. Investigation of lunar and solar tides in the ionosphere — MR. B. M. BANERJEE, Institute of Nuclear Physics, Calcutta
4. Study of absorption and dielectric properties in the microwave region — PROF. P. N. SHARMA, Lucknow University, Lucknow

5. Investigations on microwave propagation — PROF. K. SRINIVASAN, Indian Institute of Science, Bangalore
6. Design and construction of ionospheric recorder — PROF. K. SRINIVASAN, Indian Institute of Science, Bangalore
7. Study on scattering of radio waves — DR. S. S. BANERJEE, Banaras Hindu University, Banaras
8. Absorption of microwaves in 3 cm. region — MR. KRISHNAJI, Allahabad University, Allahabad
9. Polarization of downcoming waves — DR. S. R. KHASTGIR, Banaras Hindu University, Banaras
10. Nature of atmospherics — DR. S. R. KHASTGIR, Banaras Hindu University, Banaras
11. Ionospheric investigation — DR. S. K. MITRA, University College of Science, Calcutta
12. Investigation on radio valves — DR. S. K. MITRA, University College of Science, Calcutta
13. Recording and analysis of the reflection of electromagnetic waves from ionosphere — DR. K. R. RAMANATHAN, Physical Research Laboratory, Ahmedabad

Forty-nine papers have been published and two patents taken out.

Atmospheric Research Committee

THE Atmospheric Research Committee was set up by the Council of Scientific & Industrial Research in 1944 with the following objects:

(1) To promote and co-ordinate investigations on the physics of the atmosphere, solar-terrestrial relationships, and the meteorological aspects of the ionosphere and of cosmic rays; and

(2) to deal with the practical and technical problems of Indian meteorology in collaboration with the India Meteorological Department.

Prof. M. N. Saha was the first chairman of the committee. The successive chairmen of the research committee have been: Prof. H. J. Bhabha (1946-48), Dr. S. K. Banerjee (1948-51) and Mr. V. V. Sohoni (1951-53). Dr. K. R. Ramanathan is the present chairman.

In the first four years of its existence, research schemes on the following subjects were considered and recommended for support by the Atmospheric Research Committee: various aspects of cosmic rays; atmospheric ozone and radiation balance in the stratosphere; infra-red radiation in the atmosphere including solar radiation; and laboratory studies of vortices and clouds.

When, in 1949, under the auspices of the Atomic Energy Commission, a Cosmic Ray Research Committee was set up, consideration of research schemes on cosmic rays was transferred to that body. Similarly, when the Radio Research Committee was formed, problems of the ionosphere were dealt with by that body. Since 1949, the committee has concentrated its attention on problems of meteorology and hydrology and acted as a liaison body between Government departments and research institutions and has done valuable preparatory work of establishing a High Altitude Research Station in India.

HIGH ALTITUDE RESEARCH STATION

As early as 1947, the committee recommended the setting up of a High Altitude Research Station in the Himalayas. It was originally proposed that the station should undertake investigations on (1) cosmic rays, (2) high altitude meteorology, (3) snow survey and glaciology, (4) astronomy and astrophysics, (5) high altitude physiology, and (6) flora and fauna of the Himalayas. An expert committee was appointed by the Council to work out the details. At the instance of the committee a survey party was sent out to Badrinath area in 1948 to find a suitable site for the station. Representatives of the Central Waterways Irrigation & Navigation Commission (CWINC), India Meteorological Department, Geological Survey of India and the Council took part in this expedition. In May, June and August 1949, expeditions were also arranged to Sikkim, Jumnotri and Bara Lacha regions respectively. In September-November 1948, two members of the CWINC made a survey of the Mana Pass area. The reports of these expeditions prepared by Mr. J. Banerji, the leader of the expeditions, show that suitable sites for the High Altitude Research Station are available (i) near Thangu in North Sikkim, (ii) at Bara Lacha, about 20 miles from Kyelang in Lahaul district and (iii) near Mana Pass near Badrinath. Dr. S. K. Banerji, who was then the chairman of the expert committee and of the Atmospheric Research Committee, prepared a provisional draft plan for a station. The expert committee, after making a review of the reports of these expeditions, wanted to send another survey party to Mana Pass in order to organize regular weather observations and make a comparative assessment. On account of the non-availability of personnel, this expedition could not be undertaken. In the meanwhile, the basic ideas about the High Altitude Research Station have undergone a change. Some of the members of the committee felt that instead of attempting to set up a multi-purpose station, working camps should be set up and gradually developed. At the instance of the Atmospheric Research Committee, a questionnaire was issued by the Council to the concerned departments, research institutions and universities to find out if there is demand for such an institution or institutions and asking for the immediate programmes of work for which facilities were required. The response so far shows that a large number of scientists are interested in taking up studies at high altitudes. The matter is now being examined further. It appears that the two main groups for whom a High Altitude Research Station at a height exceeding 12,000 ft. is essential are the cosmic ray workers and workers on human physiology.

RESEARCH ON MICROSEISMS, SEA WAVES & SWELLS

The Atmospheric Research Committee set up a subcommittee to formulate a programme of research on microseisms, sea waves and swells. Representatives of the Meteorological Department and the Ministry of Defence were on this committee. At the instance of the committee, arrangements were made to train two officers of the Meteorological Department in sea wave observations. Wave recorders have also been installed on the recommendation of the committee at selected stations. Installation of tripartite microseismic recorders and study of microseisms by the single station method were also considered by the committee. A tripartite micro-

seismic station has been set up at Madras. A scheme of research has been sponsored at Calcutta on the subject.

INDIAN METEOROLOGICAL SOCIETY

On the recommendation of the committee, efforts have been made to form an Indian Meteorological Society. A subcommittee has been appointed to draw up a constitution and take steps to form the society.

SYMPOSIUM ON ARTIFICIAL RAIN

During the past few years, considerable public interest has been aroused in the subject of artificial rain. The Central and State Governments are also greatly interested. In order to take stock of the existing knowledge in the subject and also to assess the result of investigations so far carried out in India, mainly by Dr. S. K. Banerji, a symposium was organized by the Atmospheric Research Committee in collaboration with the India Meteorological Department in Delhi. Twenty-five papers were presented and discussions, which lasted for two days, showed that any large-scale employment of techniques for producing artificial rain in this country was premature. The papers presented at the symposium were edited and published.

On the basis of the discussion, the committee recommended the setting up of a Cloud Physics and Rain Research Unit for undertaking detailed scientific investigations on the physics of clouds, cloud formation and rain. Steps are being taken to set up a research unit under the auspices of the Council, in which the India Meteorological Department, Indian Air Force, Civil Aviation Department and the National Physical Laboratory are expected to collaborate.

The total number of sponsored research schemes is eight.

The following three schemes are being pursued at present:

1. Study of microseisms and sea waves and their correlation with cyclonic disturbances — DR. S. K. CHAKRAVARTY, Bengal Engineering College, Howrah
2. Atmospheric ozone and the weather — DR. K. R. RAMANATHAN, Physical Research Laboratory, Ahmedabad
3. Infra-red radiation from the atmosphere and solar radiation — DR. L. A. RAMDAS, Meteorological Department, Poona.

Twenty-seven papers have been published and four patents taken out.

Committee on Measurement of Geological Time in India

On the basis of a memorandum submitted to the Council by Prof. M. N. Saha and Dr. D. N. Wadia, the Council set up the Committee on Measurement of Geological Time in India in 1947 under the chairmanship of Dr. Wadia. The memorandum pointed out that studies on the measurement of geological time in India will not only help in understanding the chronological order of the great undated rock systems of the Deccan and the general geological layout of the Indian subcontinent, but will also help mineralogists and prospectors in locating minerals and

ores of economic value and in tracing the continuity of the widely scattered mineral-bearing pegmatite veins and dykes through wide stretches of the country.

PROGRAMME OF WORK

The following programme of work was suggested for the committee:

1. A systematic examination of the radioactive contents of minerals occurring in different rock systems in India
2. Similar examination of rock specimens obtained from well-marked igneous intrusives and traversing rocks of doubtful ages
3. Uranium, thorium and radium contents of granites and gneisses
4. The correlation of the mica pegmatites of Gaya, Nellore and Mysore; uranium-bearing minerals like uraninite, thorinite, torbernite, carnotite, allanite, gadolinite, samarskite, columbite, etc.
5. The determination of the much-debated sequence of Archaean rocks in Chota Nagpur, Mysore and Central Provinces, the age of the Himalayan Central gneiss and the basic intrusive dykes
6. Age levels of different horizons of the Deccan Trap Lava pile
7. Examination of radioactive content of Indian minerals by (i) ionization electrometer, (ii) mass spectrograph, (iii) hyperfine structure methods, (iv) pleochroic haloes, (v) lead/uranium ratio, and (vi) helium ratio

On the recommendation of the committee, two research scholars were trained in the techniques of measurement of geological time under the direction of Prof. C. Mahadevan and Dr. R. S. Krishnan.

Reports of the work of this committee are exchanged with those of the corresponding Committee of the National Research Council, U.S.A. Dr. John Putnam Marble, Chairman of the U.S.A. Committee, has acknowledged the "fine piece of work" done in India and has expressed the view that the report was "an extremely interesting and very worthwhile document". The reports of the committee are made available to the Indian Atomic Energy Commission.

A popular pamphlet explaining the results obtained to the lay public is now under publication.

The three research schemes sponsored by the committee have given valuable results. The results obtained at Waltair and Bangalore with regard to radioactivity of South Indian rocks are made available to the Atomic Energy Commission. The palaeobotanical work at the Birbal Sahni Institute of Palaeobotany, besides providing valuable training to young scientists, is of value in the better understanding of the coal resources of India.

Nine schemes have been sponsored by the committee.

Investigations on the following schemes are in progress:

1. Micro-palaeobotanical investigations for the age determination of rocks — Director, Birbal Sahni Institute of Palaeobotany, Lucknow
2. Palynology — Director, Birbal Sahni Institute of Palaeobotany, Lucknow

3. Age determination of certain igneous and metamorphic rocks of pre-Cambrian era — PROF. R. S. KRISHNAN, Indian Institute of Science, Bangalore, and PROF. C. MAHADEVAN, Andhra University, Waltair
4. Oceanographic research — PROF. C. MAHADEVAN, Andhra University, Waltair

Twenty-two papers have been published.

Building Research Committee

THE Building Materials Research Committee was set up in April 1944 with Sir Teja Singh Malik as chairman. The name of the committee was subsequently changed to the Building Research Committee.

At the first meeting held in September 1944, the committee discussed the problems of building research in India and concluded that the magnitude and importance of the problems were such that a separate institute should be established to investigate them. The committee recommended that an institute for building research should be included in the chain of national laboratories to be set up by the Council.

As a first step, the committee recommended that a Building Research Unit should be set up in collaboration with a university or an engineering college. The Council accepted the recommendation and, after making necessary enquiries, decided to locate the Building Research Unit at Roorkee in collaboration with the Thomason College of Engineering. An officer on special duty was appointed in 1947 and necessary staff recruited. Laboratory and workshop facilities were provided by the Thomason College. The problems referred to the unit by State Engineering Departments and individual scientists were scrutinized by the committee and a programme of research was drawn up for the unit.

Tentative proposals for the establishment of the Central Building Research Institute were considered by the committee in December 1947. A revised plan which was in conformity with the plans prepared for other national laboratories was finalized and details regarding the scope and functions, divisions, personnel, and financial requirements were worked out. The plan was approved by the Council in 1949 and research work was started in the Central Building Research Institute, Roorkee, in April 1951, when the Building Research Unit ceased to function.

The Building Research Committee represented India on the Committee of Commonwealth Countries and helped in compiling information on physiological and other factors affecting life and work in the tropics.

Notes on the use of soil as a building material and on the basic minimum requirements for buildings were prepared and data on cheap village and urban housing and cheap building materials were collected for the use of the Expert Committee on Low Cost Housing set up by the Council.

On the basis of the recommendations made by the Expert Committee on Low Cost Housing, a planned programme of research has been formulated after taking into consideration the facilities available in the Central Building Research Institute, the National Physical Laboratory of India, the Forest Research Institute and other research institutions in the country.

The Building Research Committee was reconstituted on 1 April 1953. Maj.-Gen. H. Williams is the chairman of the committee.

Nineteen papers have been published.

Road Research Committee

A Road Research Committee has been recently (April 1953), constituted with Mr. H. P. Mathrami as chairman. The functions of the committee are:

1. To advise the Council of Scientific & Industrial Research on road research problems;
2. to initiate and foster road research in India and recommend financial grants where necessary;
3. to help to co-ordinate road research under various auspices in the country;
4. to make a survey of the present knowledge in the subject, take stock of research work done in the country and formulate a planned programme of research for the advancement of knowledge or the application of such knowledge to problems of national or industrial importance; and
5. to watch the progress of specific schemes which may be taken directly under the auspices of the committee.

Internal Combustion Engines Research Committee

THE Internal Combustion Engines Research Committee was set up in January 1941, under the chairmanship of Mr. J. C. Mahindra with the object of sponsoring investigations on (1) production of components or complete engines offering prospects of immediate development, with particular reference to war demands; and (2) development of an internal combustion engine industry in India.

The committee was reconstituted in 1945 with Dr. M. Ishaq as chairman. Dr. J. C. Ghosh took over the chairmanship in 1947.

Shortly after its formation, the committee surveyed the position of the I.C. engine industry in India and formulated recommendations for utilizing the capacity of the existing units of industry. The findings and recommendations of the committee were embodied in a report.

NATIONAL LABORATORY FOR I.C. ENGINES RESEARCH

The setting up of a National Internal Combustion Engines Research Laboratory was recommended by the committee in March 1945. In the same year, the Indian Institute of Science, Bangalore, started a department for postgraduate training and research in internal combustion engineering. The committee recommended that this department should confine its activities to (1) the training of personnel for the industry and (2) the researches of a long-range character, while the proposed national laboratory was to undertake work connected with (1) testing of I.C. engines for land transport, of stationary engines for power purposes, and of smaller engines for water transport; (2) testing and research on fuels and lubricating oils; (3) testing and research on metals and alloys as applied to particular components of engines and accessories; (4) short-range research of immediate practical importance to the industry; and (5) pilot plant investigations.

A subcommittee was appointed under the chairmanship of Dr. A. H. Pandya to prepare a plan for the national laboratory. The plan was modified in consultation with Prof. H. A. Havemann and finalized in 1949. The Council of Scientific & Industrial Research, however, decided to postpone the consideration of the proposal.

RESEARCH ON GAS TURBINES

A subcommittee to consider and formulate the general policy on gas turbine research was constituted in December 1950. The subcommittee made a survey of the facilities available for gas turbine research in various institutions in India. The following institutions agreed to co-operate in the work: (1) National Physical Laboratory of India: experimental and theoretical investigations on heat transfer; (2) Central Glass & Ceramic Research Institute: ceramic blade materials; testing of spalling resistance and corrosion; (3) Fuel Research Institute: experimental investigations on injection and combustion of heavy liquid fuels and design of combustion chambers; (4) National Metallurgical Laboratory: development of suitable alloys, production techniques and testing facilities for turbine blade materials; (5) Ordnance Factories and *Hindustan Aircraft Ltd.*: casting and machining; (6) Indian Institute of Science, Bangalore: testing of compressor and gas turbine blades in the high speed wind tunnel; creep testing of high duty turbine alloys.

A programme of gas turbine research has been drawn up by Prof. Havemann, Dr. Sen Gupta, Dr. Whitaker and Dr. Atma Ram.

The committee recommended to the Ministry of Education that a non-recurring grant of Rs. 2 lakhs and an annual recurring grant of Rs. 25,000 should be made to the I.C. Engineering Department of the Indian Institute of Science, Bangalore, for the extension of instruction and research in gas turbines. The grant was made in February 1950.

The Governing Body of the Council has appointed a special committee, with Mr. J. R. D. Tata as chairman, to examine the subject of research, development and manufacture of gas turbine and jet propulsion engines in India.

TRAINING OF TECHNICAL PERSONNEL

In accordance with the recommendation of the committee, the Ministry of Education in their programme for advanced technical training abroad selected 15-20 candidates in 1945, 1946 and 1947 for specialized training in I.C. engineering.

I.C. ENGINE DEVELOPMENT BOARD

The committee recommended the constitution of a Development Board under the Directorate General of Industries & Supplies (D.G.I.S.) as a standing body for framing a long-range policy for the development of the I.C. engine industry in India. Two members of the I.C. Engines Research Committee were appointed members of the Development Board for Mechanical Engineering.

I.C. ENGINE MANUFACTURERS' ASSOCIATION

The committee recommended the formation of an I.C. Engine Manufacturers' Association.

The establishment of an institution for testing engines for air transport and another for development for I.C. engines for use in surface and under-water operations was recommended.

SPECIFICATIONS FOR I.C. ENGINES

The need for assisting Indian industry to undertake the manufacture of engines required for defence purposes has been stressed by the committee. The I.C. Engineering Department of the Indian Institute of Science, Bangalore, has taken steps to design an engine, according to the specification received from the Defence Department, which may be useful in the trainer aircraft HT-2.

SYMPOSIUM

A symposium on "Problems relating to the Internal Combustion Engines Industry in India" was held on 5-6 April 1952, in Bangalore, under the joint auspices of the Internal Combustion Engines Research Committee and the Indian Institute of Science, Bangalore. Representatives of the Government, industry and research institutes participated in the discussions. The papers presented may be classified into three groups: (a) those relating to research and development carried out in India; (b) those reviewing recent developments abroad; and (c) those presenting proposals for investigation and development in future.

Six research schemes have been sponsored so far.

The following four schemes are under investigation:

1. Hot air engines and their development — PROF. H. A. HAVEMANN, Indian Institute of Science, Bangalore
2. Design and development of air-cooled aero-Otto-engine — PROF. H. A. HAVEMANN, Indian Institute of Science, Bangalore
3. Development of heavy duty parts of internal combustion engines — PROF. H. A. HAVEMANN and PROF. M. S. THACKER, Indian Institute of Science, Bangalore
4. Development of a "flash steam generator" — MR. R. K. MUKERJI, Uttarpara

Six papers have been published.

Chemical Research Committee

The following committees were constituted by the Board of Scientific & Industrial Research in 1940 and 1941: Fertilizers Committee; Sulphur Committee; Chemical and Distillation Plants Committee; Dyestuffs Committee; Graphite, Carbon and Electrodes Committee; and Heavy Chemical Industries Committee. The Electro-chemical Industries Committee was constituted in December 1943, and it took over the functions of the Graphite, Carbon and Electrodes Committee.

The Fertilizers Committee and the Sulphur Committee were merged with the Heavy Chemicals and Chemical Industries Committee in 1944.

The Dyestuffs Committee was functioning as a separate committee till 1948, when it was changed into a subcommittee of the Heavy Chemicals and Chemical Industries Committee. The Electrochemical Industries Committee and the Heavy Chemicals and Chemical Industries Committee were integrated and reconstituted as the Chemical Research Committee in 1950-51.

The scope and functions of the committee are:

1. To act as an advisory body on researches in the field of chemistry, both fundamental and applied;
2. to initiate, organize and co-ordinate research on a planned basis;
3. to examine and formulate proposals for assistance to research schemes to be investigated in an institution, departmentally or non-departmentally;
4. to recommend financial assistance from the Council and to watch the progress of work under the schemes;
5. to survey the facilities available for chemical research and to formulate a co-ordinated programme of work up to the pilot plant stage; and
6. to formulate schemes of research for the development of industries and allocate them to suitable research laboratories.

The following aims are kept in view in sponsoring industrial research schemes:

1. Improvement of existing industries
2. Reduction in production costs so that the products of Indian chemical industry can stand competition with imported products
3. Utilization of raw materials plentifully available in India
4. New processes of manufacture

As regards fundamental research, the need for developing schools of specialized research in universities and research institutions in the country is kept in view.

PROJECTS SPONSORED BY THE COMMITTEE

Dyestuffs — An exploratory committee to consider the ways and means for setting up a synthetic dyestuffs industry in India was formed early in 1941, with Sir Ardeshir Dalal as chairman. The terms of reference to the committee were: (1) to survey the consumption of various dyes in India; (2) to survey the availability of raw materials and heavy chemicals for the manufacture of dyestuffs; (3) to consider the practicability, both technical and economic, for the manufacture of dyestuffs; and (4) to consider the practicability, both technical and economic, for the manufacture of such dyes in India as are capable of being produced within a period of fifteen years. Besides exploring the possibilities of establishing a dyestuffs industry in India, the committee was also required to consider problems of research in synthetic as well as vegetable dyes referred to it by the Board of Scientific & Industrial Research. Dr. John Mathai succeeded Sir Ardeshir Dalal as chairman of this committee in 1946.

To assist the committee in its work, Dr. K. Venkataraman was requested to undertake a survey of the availability of raw materials for the dyestuffs industry.

The report which was submitted by the committee provides valuable information on the consumption of dyes in India, the availability of raw materials and the possibilities for producing intermediates, plants and equipment required, and location and organization of a dyestuffs industry and its feeder industries. The committee prepared a fifteen-year plan for the manufacture of fifty-one dyes.

Two schools of research in dyestuffs technology came into existence as a result of the research schemes sponsored by the Council. The Council sanctioned funds for a Dyestuffs Technology Department and a number of research scholarships in the Bombay University. As the Indian dyestuffs industry continues to develop, the experience of the team of workers would be of considerable help. As pointed out by Dr. K. Venkataraman in the two volumes on the *Chemistry of Synthetic Dyes* (Academic Press, New York, 1952): "Much of the work on dyes in my laboratory has been under the auspices of the Council of Scientific & Industrial Research".

Electro-chemical Research — The need for the establishment of an Electro-Chemical Research Institute was stressed by the Electro-chemicals Research Committee at the meeting held in April 1944.

The Sulphur Problem — The Sulphur Committee, appointed in 1940, initiated research on: (1) beneficiation of Baluchistan sulphur; (2) utilization of other sources of sulphur, such as pyrites and gypsum; and (3) extraction of sulphur compounds from coal and other minerals.

In view of the complete absence of naturally occurring sulphur in India and the great importance of sulphuric acid for industry, the Board of Scientific & Industrial Research recommended that the Government of India should put up a plant for the manufacture of sulphuric acid from gypsum.

Research Chemicals — The Chemical Research Committee initiated a scheme for the preparation and supply of research chemicals normally available in the market. The import of the chemicals presents difficulties and involves delays. As a result of the work under this scheme, ninety-seven research chemicals are now being prepared by nine different laboratories. So far fourteen institutions have been supplied with the chemicals at nominal cost. An officer appointed by the committee, working under the Director, National Chemical Laboratory, Poona, keeps liaison between the producing laboratories and the consumer laboratories.

Forty-two research schemes have been sponsored.

Work on the following schemes are in progress:

1. Halogenation of organic compounds — DR. S. S. JOSHI, Banaras Hindu University, Banaras
2. Investigations on the electro-chemical properties of resin systems in relation to reactions involving exchange of ions — DR. B. N. GHOSH, Calcutta
3. Recovery of sulphur as hydrogen sulphide from sulphates — DR. J. G. KANE, Bombay
4. Economic utilization of tamarind seed — DR. A. N. PURI, Bombay
5. Studies in stereochemistry — PROF. BAWA KARTAR SINGH, Banaras Hindu University, Banaras

6. Pilot plant investigation for the manufacture of ether and ethylene dichloride from alcohol — DR. D. N. DARUVALLA, Shri Ram Institute for Industrial Research, Delhi
7. Anthraquinonoid and sulphurized vat dyes — DR. K. VENKATARAMAN, Department of Chemical Technology, Bombay University, Bombay

Sixty-four papers have been published and 25 patents taken out.

Biochemical Research Committee

THE Molasses Research Committee was one of the twelve research committees constituted by the Government of India in 1940, under the Board of Scientific & Industrial Research. Its main function was to find ways and means of utilizing the surplus molasses from Indian sugar factories. Dr. B. C. Guha was appointed chairman of the committee. The problems formulated by the committee for study were: (1) recovery of potassium salts from molasses, and (2) utilization of molasses as a raw material for industrial fermentations.

The committee was reconstituted in 1944 and its scope was enlarged to include industrial fermentations and biological products. The Industrial Fermentation and Biological Products Committee was again reconstituted in 1951 under the name Biochemical Research Committee, and its scope was further widened with a view to bringing food technology and biochemistry within its purview. Dr. Bashir Ahmed and Dr. M. Damodaran have acted as chairmen of the committee. The present chairman is Dr. V. Subrahmanyam, Director, Central Food Technological Research Institute, Mysore.

The schemes initiated by the committee and sponsored by the Council have resulted in the establishment of active centres of biochemical research in several universities and scientific institutions in India.

NATIONAL COLLECTION OF TYPE CULTURES OF MICRO-ORGANISMS

A major project on collection of type cultures was sponsored by the committee in 1942. Work on this project was initiated by Prof. M. Sreenivasaya at the Indian Institute of Science, Bangalore. Under his guidance, a large collection of bacteria, fungi and yeasts of importance to research and industry, with well defined morphological and physiological characteristics and reproducible performance, was built up over a period of eight years. The whole collection was transferred on a permanent basis to the National Chemical Laboratory, Poona, in 1950, and is now housed in the Biochemistry Division of the laboratory.

The collection contains about 700 cultures of importance to research and industry, isolated in India or obtained from similar collections in other countries. Additions are made from time to time. The more important groups of micro-organisms in the collection are the following: (1) organisms employed for the microbiological assay of amino acids and vitamins; (2) wine yeasts; (3) distillery yeasts for the production of high alcohol content distillery washes; (4) yeasts for bread making; and (5) organisms for the production of citric and lactic acids, butanol, acetone, antibiotics and vitamins.

Cultures of micro-organisms from the collection with reliable and reproducible performance characteristics are supplied to research workers and to fermentation industries on request. The methods adopted in U.K. are followed in the maintenance and distribution of organisms.

A Directory of Collections of Micro-organisms and a List of Species maintained in India has been recently published. It may be recalled that the Commonwealth Specialist Conference on Culture Collections of Micro-organisms held in 1947 also recommended the publication of national directories by member countries. A National Committee of Type Cultures has been set up by the Ministry of Natural Resources & Scientific Research and the Officer-in-Charge of the National Collection represents the Council on this committee.

SURVEYS & REPORTS

A region-wise survey was initiated by the committee to study the possibilities of starting fermentation industries in India. Information was collected on the following: (a) raw materials for fermentation industries available in different parts of the country; (b) statistics of imports of fermentation products; and (c) estimates of present and future requirements in respect of fermentation products and possibilities for producing them in the required quantities.

The committee has taken steps to prepare and issue reports on the following subjects: (a) materials of vegetable and animal origin as raw materials for the chemical industry; (b) recent literature on aviation spirit production from fermentable materials; (c) alcohol-petrol blends for use in internal combustion engines; and (d) production of cattle feed by the action of micro-organisms on materials such as molasses, sawdust, paddy husk, bagasse and jute stalks.

The sponsored scheme on the studies on the cytogenetics of yeasts and fungi has resulted in the production of sixty new strains of yeasts and the evolution of a mutant yeast suitable for food yeast and riboflavin production.

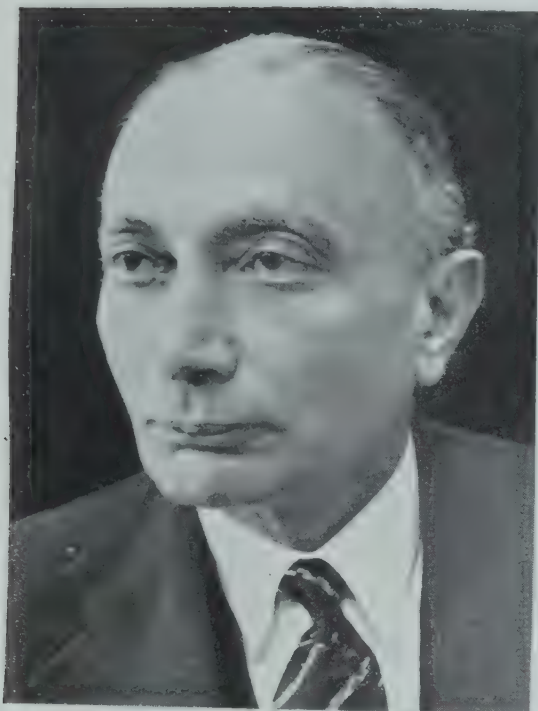
The sponsored scheme on increasing the alcohol concentration in distillery washes has led to the evolution of a yeast strain with high attenuating power, capable of withstanding high concentration. By employing this strain, it has been possible to raise the alcohol concentration in the wash to 10-14 per cent (v/v).

Twenty-five research schemes have been sponsored.

Research work on the following problems is under way:

1. Nutritive value of palm *gur* — DR. (MRS.) KAMALA SOHONIE, Institute of Science, Bombay
2. Studies on trypsin inhibitors in Indian foodstuffs — DR. (MRS.) KAMALA SOHONIE, Institute of Science, Bombay
3. Microbial production of vitamin B₁₂ — DR. S. C. ROY, Calcutta University, Calcutta
4. Fat production by microbial farming — DR. H. N. DE, M.G.M. Medical College, Indore
5. Protein concentrates from green leaves — DR. B. C. GUHA, University College of Science, Calcutta

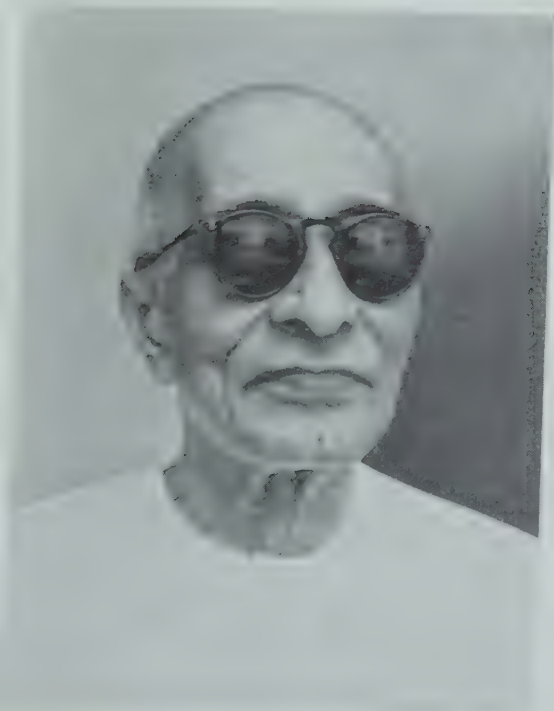
PAST PRESIDENTS, C.S.I.R.



SHRI ARDESHIR DALAL
(1944-45)



MR. A. A. WAUGH
(1945-46)



SHRI C. RAJAGOPALACHARI
(1946 and 1947)



DR. JOHN MATHAI
(1946-47)

6. Use of antibiotics in the storage of foodgrains — DR. S. K. BOSE, Calcutta University, Calcutta
 7. Determination of processing conditions for the preservation of Indian vegetables — DR. A. N. BOSE, College of Engineering and Technology, Calcutta
 8. Thyroid activity of thyroglobulin and other iodoproteins — DR. P. S. SARMA, Madras University, Madras
- Eighty-nine papers have been published and seven patents taken out.

Pharmaceuticals & Drugs Research Committee

THE Pharmaceuticals & Drugs Research Committee was constituted in 1940, with Dr. J. N. Ray as chairman. Sir R. N. Chopra, Major-General S. L. Bhatia and Dr. Jivraj N. Mehta have acted as chairmen of this committee during the past ten years. Major-General S. S. Sokhey is the present chairman.

The committee was confronted, at the time it was constituted, with the problem of shortages of essential drugs due to the war. The committee initiated a programme of work for overcoming the shortages and started investigations relating to (1) manufacture of synthetic drugs like phenacetin, salvarsan, carbarsone and others, whose methods of preparation were well established; (2) natural drugs like atropine, emetine, gallic acid and thymol from known sources, taking into account the scarcity of chemicals and solvents; (3) glandular products like adrenaline, thyroxine and pituitrin according to methods modified to suit Indian conditions; and (4) commercial exploitation of alkaloids of *Rauwolfia serpentina* and *kurchi* bark, resin from bhilawan nuts, bitter constituents of *nim* and other indigenous plant products.

In 1944 the committee decided to switch over from a programme of immediate *ad hoc* investigations to a planned programme of long-range research to help the indigenous drug industry. A subcommittee was appointed to prepare a planned programme of work to be circulated to universities, research institutes and medical colleges.

The subcommittee also recommended the setting up of a Central Drug Research Institute, for which the tentative scheme was prepared by Dr. B. Mukerji. The scheme was suitably modified and submitted to the Council for acceptance. The Council accepted the proposal in 1947.

After the establishment of the institute, the Pharmaceuticals & Drugs Research Committee recommended the creation of a Botanical Division, a Division of Biophysics, a Unit for Hormone Research and a Section for Commercial Testing of Drugs at the institute.

The committee has under consideration the compilation of a monograph on the indigenous drugs of India. The first part of the work, entitled the *Indian Pharmaceutical Codex*, has been published. The *Glossary of Indian Medicinal Plants* by Col. R. N. Chopra, chairman of the research committee, is under publication.

MALARIA CHEMOTHERAPY

A subsidiary committee was set up by the Council in August 1948 to initiate researches on malaria chemotherapy. The committee surveyed

the status of our knowledge of antimalarial drugs in prophylactic, suppressive and clinical therapy and the relative merits of antimalarials such as quinine, mepacrine, paludrine and chloroquin in the treatment of malaria. The committee concluded that quinine products still form the most important and effective remedy for the treatment of malaria. The committee noted that while synthetic antimalarials were being imported, stocks of quinine products were accumulating in the Government manufacturing centres at Mungpoo and Naduvattam. The committee recommended that special efforts should be made to utilize quinine and its products in the treatment of malaria and, if necessary, restrictions may be imposed on the importation of foreign quinine and synthetic antimalarial drugs into India. The committee recommended that Government factories should explore ways and means of reducing the cost of production of quinine.

The committee has initiated research on screening of antimalarial preparations synthesized in various laboratories in India. Studies have been undertaken on the metabolism of host, drug and parasite with particular reference to Indian strains and biochemical changes in the host following the attack of malaria. These investigations are in progress at the Malaria Institute of India, Delhi, Bengal Immunity Research Laboratory, Calcutta, and the School of Tropical Medicine, Calcutta.

At the suggestion of the committee, statistical analysis is being made of the data collected from therapeutic trials of antimalarial drugs under the Director General, Armed Forces Medical Services.

Trials on drugs which have been claimed to prevent malaria relapses have been undertaken in two areas — one in which intensive control has been effected by the use of DDT, and another, in the centre of hills, where there has been no fresh infection — to obtain a correct appraisal of the effectiveness of a particular drug or a combination of drugs in preventing relapse.

PHARMACOLOGICAL RESEARCH

The Pharmaceuticals & Drugs Research Committee has drawn attention to the paucity of facilities and personnel for pharmacological work and has recommended measures for the training of pharmacologists. A research unit was set up at Calcutta under the direction of Dr. B. Mukerji and this unit has since been merged with the Central Drug Research Institute, Lucknow. A subcommittee was constituted (1) to survey the pharmacological work carried out in India and to suggest ways and means for encouraging pharmacological and biological research of fundamental and applied character; (2) to review the present position of indigenous drugs industry; and (3) to explore the possibilities of developing farms for laboratory animals. A note based on the findings of this committee was prepared and circulated to the Government departments, research institutions and individual research workers concerned and also to industry. Co-operation of the Government and other institutions has been sought in the matter of supply of experimental animals to facilitate pharmacological investigations. The committee recommended that: (a) intensive efforts should be made to develop the production of antibiotics and other synthetic remedies, (b) drug research in India should be directed towards the discovery of newer antibiotics from indigenous sources; (c) a chemiotherapeutic approach should be made towards the treatment of diseases

common in India, such as malaria, tuberculosis, leprosy, cancer and gastrointestinal diseases; and (d) to achieve this objective, it is essential that coal tar intermediate and calcium carbide industries should be developed as early as possible.

Among the recommendations of a general character made by the Pharmaceuticals & Drugs Research Committee mention may be made of the recommendation relating to the amendment of the Patent Law which discriminates against research workers in synthetic drugs. At the instance of the committee, the Council has under consideration the starting of a journal of biological sciences. A microbiological centre has been set up at St. Xavier's College, Bombay, for studies on natural and synthetic antibiotic substances.

An insecticide testing centre has been established at the Malaria Institute, Delhi, for testing insecticides developed under the research schemes sponsored by the Council.

Col. R. N. Chopra, chairman of the committee, has presented his valuable collection of medicinal plants to the Central Drug Research Institute.

SYMPOSIUM

A symposium on "Antibacterial Substances from Various Sources" was held in March 1953, in Bombay, in which Sir Alexander Fleming participated. Over 20 papers dealing with the isolation, testing, standardization, chemistry, therapeutic uses, and mode of action of antibacterial substances were read and discussed.

Research schemes on plant constituents have resulted in the isolation and study of a number of active principles. Active principles from *nim* (*Azadirachta indica*) have been made use of in the preparation of specifics. Processes for the manufacture of glandular products such as pituitrin, thyroxine and insulin have been established. As a result of detailed survey, cultivation and improvement of medicinal plants carried out in the North-western Himalayan region a number of drugs are being cultivated on a commercial basis. A comprehensive glossary of Indian medicinal plants has been completed. A survey of plants recognized in the B.P. and their substitutes growing in India has been published. A herbarium containing 15,000 sheets has been built up.

Fifty schemes have been sponsored so far.

The following nineteen schemes are under investigation:

1. Preparation of cortisone and corticosterone analogues — DR. D. K. BANERJI, Calcutta
2. 8-Amino quinoline derivatives as antimalarials — DR. U. P. BASU, Bengal Immunity Research Institute, Calcutta
3. Biological studies on malarial parasites — DR. U. P. BASU, Bengal Immunity Research Institute, Calcutta and DR. R. N. CHAUDHARY, School of Tropical Medicine, Calcutta
4. Survey of fungus flora of India in search of antibiotics — DR. S. R. BOSE, R. G. Kar Medical College, Calcutta
5. Finding a rich source of stigmasterol and its isolation — DR. R. N. CHAKRAVARTI, School of Tropical Medicine, Calcutta
6. Survey of medicinal and economic plants of Ladakh — COL. R. N. CHOPRA, Drug Research Laboratory, Jammu-Tawi

7. Cultivation and commercial development of medicinal and economic plants of N.W. Himalayan region — COL. R. N. CHOPRA, Drug Research Laboratory, Jammu-Tawi
8. Chemical and pharmacological investigation on cardiac and uterine drugs of indigenous *Materia Medica* — DR. B. N. GHOSH, R. G. Kar Medical College, Calcutta
9. Preparation of a polyvaccine for typhoid, cholera and dysentery — DR. S. P. GUPTA, Medical College, Lucknow
10. Screening of antimalarial drugs — COL. JASWANT SINGH, Malaria Institute of India, Delhi
11. Biological assay of insecticides — COL. JASWANT SINGH, Malaria Institute of India, Delhi
12. Sulphur analogues of polycyclic hydrocarbons and sterols for their carcinogenic and cancer inhibiting properties — DR. R. V. KHANOLKAR, Indian Cancer Research Centre, Bombay
13. Production of an antibiotic substance by *Streptomyces* spp. — DR. P. N. NANDI, Bose Research Institute, Calcutta
14. Indian cardiac drugs — DR. S. RANGASWAMI, Andhra University, Waltair
15. Synthesis of new types of insecticides — DR. T. R. SESHADRI, Delhi University, Delhi
16. Chemical investigation of Indian lichens — DR. T. R. SESHADRI, Delhi University, Delhi
17. Synthesis of kelling, its isomers and related compounds — DR. T. R. SESHADRI, Delhi University, Delhi
18. Chloramphenicol (chloromycetin) analogues and derivatives — DR. B. D. TILAK, Department of Chemical Technology, Bombay University, Bombay
19. New paths to chloramphenicol (chloromycetin) — DR. A. TYABJI, Bombay

One hundred and five papers have been published and thirteen patents taken out.

Fuel Research Committee

THE Fuel Research Committee was constituted in 1940, with the following terms of reference: to organize research relating to fuel, to survey the present position of fuel research in India and formulate a planned programme for the advancement of research and the application of knowledge available; and to advise the Council on the allocation of grants for fuel research in universities and research centres.

At the first meeting held in August 1940, the committee recommended that a Central Fuel Research Institute should be set up and that, in addition to other problems of research, it should direct particular attention to:

1. Physical and chemical survey of Indian coals

2. Processing and preparing coal with special reference to metallurgical coke
3. Low temperature carbonization of coal

On the recommendation of the committee five Regional Coal Survey Stations have been established for Jharia, Raniganj, Bokaro-Ramgarh-Karanpura, Central India and Assam coalfields. For the systematic survey of coalfields of South India, a Coal Survey Station, functioning under the joint auspices of the Council of Scientific & Industrial Research and the Central Laboratories for Scientific & Industrial Research, Hyderabad (Dn.), has been started.

COAL BLENDING & COKING RESEARCH (C.B.C.R.) SUBCOMMITTEE

The Coal Blending & Coking Research Subcommittee, which is a local committee comprising mostly of experts of the *Tata Iron & Steel Co. Ltd.*, has been constituted for the purpose of supervising the technical and administrative work of the Coal Blending & Coking Research Scheme.

COAL TAR SUBCOMMITTEE

The Coal Tar Subcommittee was appointed in February 1949 to enquire into the reasons responsible for the poor quantity and quality of tar produced from Indian coke ovens and to suggest measures for improvement. The committee recommended that an attempt should be made to correlate oven conditions with yield and nature of tar produced and that a programme of research should be drawn up and a comprehensive study of the properties of Indian coals and coal products should be undertaken by the Fuel Research Institute. A questionnaire was circulated to Indian byproduct oven operators and it was ascertained that the yield of tar was roughly the same, irrespective of the type of oven, under the operating conditions prevailing in the country. The poor yield of tars was apparently attributable to the inherent nature of the coals themselves. However, as there were considerable differences in the nature of the tars produced, the committee recommended that the Fuel Research Institute should undertake: (1) laboratory scale investigations into the nature and properties of tars produced in byproduct ovens, including fundamental research on the probable causes of low yields; and (2) pilot plant scale investigations on Indian coals under closely controlled conditions so that operating conditions can be correlated with the nature and yield of tars produced. With the transfer of the Swoboda electric oven from the Tisco to the Fuel Research Institute, facilities for laboratory as well as pilot plant investigations are now available at the Fuel Research Institute for studies on this problem.

PILOT PLANTS

The committee has stressed the importance of pilot plant investigations so that the results of researches on coal can be pressed for utilization by industry. A five-year programme of pilot plant work prepared by the committee has been approved by the Planning Commission.

PUBLICATIONS

The results obtained under the schemes initiated by the committee have been published in the form of monographs and reports, some of which have attracted international attention. These include (1) *Washability of Indian Coals*; (2) *Blending of Coals for Coking*; and (3) *Indian Coals—Their Nature & Composition*. To supplement the work on *Washability of Indian Coals*, a series of nine monographs have been prepared by Dr. Whitaker and Dr. Sarkar, under the title *Studies on Coal Washability*. The tenth study, dealing with the washability characteristics of coals from mid-Jharia coalfields, is under preparation. These studies have been compiled in order that members of the mining industry and others interested may realize the potentialities (and difficulties) of coal washability in the country.

Researches carried out under the direction of the committee on coal washing and coal blending have established that India's resources of high grade metallurgical coal could be extended up to 50 per cent. Practical recognition to this has been given by the industry by its decision to set up coal washeries, and the Government of India agreeing to the setting up of a blast furnace on blended coke. Publication on the results of the schemes on washability and the blending of coals have attracted international attention.

Valuable fundamental knowledge has been gained in the spectroscopic investigations of fuels and combustion under way in the Institute of Science, Bombay.

Ten schemes were sponsored so far. The following schemes are under investigation:

1. Pilot plant investigation on briquetting of Indian coals — Director, Central Laboratories for Scientific & Industrial Research, Hyderabad
2. Investigation on the making of briquettes for charging the low shaft furnace — DR. D. JAGAT RAM, *Tata Iron & Steel Co. Ltd.*, Jamshedpur
3. Mechanism of explosions — DR. N. R. TAWDE, Institute of Science, Bombay
4. Palaeobotanical survey of Indian coals — Director, Birbal Sahni Institute of Palaeobotany, Lucknow

Fifteen papers have been published.

Mining Research Committee

In 1948, the Principal, Indian School of Mines & Applied Geology, Dhanbad, submitted a proposal to the Government of India for establishing a Mining Research Station in India on the model of similar research stations in U.K. and U.S.A. The object of establishing the station is to promote study and investigation on the safety and efficiency in mining operations and on the health of people engaged in mining work. The work of the station will cover all types of mines and mining in India. The Director of the Bureau of Mines welcomed the proposal and suggested that the Mining Research Station should be attached to the Fuel Research Institute to save expenditure, both capital and recurring. The

Ministry of Finance approved the scheme in principle and suggested that a detailed plan for the station should be prepared.

The Council of Scientific & Industrial Research constituted a Mining Research Committee, with Dr. J. W. Whitaker as convenor, for preparing a plan for the establishment of the station. The plan was finalized in 1952.

The programme of work of the station would include such problems as mine ventilation, mine gases, mine dusts, mine lighting and spontaneous combustion in the short-term programme, and explosives, explosions and fires, safety in mines, stowing in mines, haulage, mining methods, underground gasification of coal, etc., in the long-term programme.

The establishment of the station would involve an estimated capital expenditure of Rs. 11.2 lakhs and a recurring expenditure of Rs. 2 lakhs per annum for the first three years.

The Governing Body of the Council has accepted the plan, and the Government of India has been approached for the allocation of necessary funds. The proposal has been referred to the Planning Commission for inclusion in the revised Five-Year Plan.

The committee was reconstituted in 1953 with Mr. N. Barraclough as chairman.

Metals Research Committee

THE Metals Research Committee was set up in 1940 with Sir Jehangir Ghandy as chairman. The functions of this committee are: (1) to initiate researches of direct interest to the metallurgical industries of the country; (2) to prepare a planned programme of research; and (3) to co-ordinate the research activities in metallurgy.

The committee's activities were directed, in the initial stages, to researches bearing on the war effort. At the instance of the D.S.I.R., Jamshedpur was declared as the headquarters for metallurgical research in the country. At subsequent meetings proposals were adopted for the planning and organization of the National Metallurgical Laboratory. The committee surveyed the needs of the Indian metallurgical industry and prepared a programme of research which is being implemented. The committee also prepared a detailed report on the development of the non-ferrous metal industry in India.

The committee keeps a watch over developments in metallurgical research, and suggests and allocates problems for investigation in the National Metallurgical Laboratory, other research institutions and universities.

RECOMMENDATIONS

High Duty Cast Iron—In 1941 the Metals Research Committee instituted a research scheme on the development of high duty cast irons in India. A subcommittee was set up to carry out the investigation. A report on the utilization of high duty cast irons in India was prepared and this report has been printed and published by the Railway Board in the proceedings of the Indian Railway Conference Association.

Assay & Development of Zinc Resources—On the recommendation of the committee, the Government of India set up a special committee,

with Sir J. J. Ghandy as chairman, to make recommendations with regard to the steps which should be taken to assess the resources of zinc ores in India, location of one or more smelting plants and the agency to be placed in charge of these plants. The committee's report to the Government is now under examination.

Iron Production without Coking Coal—The committee has sponsored a project for investigating the low-shaft furnace process of making iron without coking coal. The work will be undertaken jointly by the Tata Laboratories and the National Metallurgical Laboratory, under the direction of the Metals Research Committee. This project which involves a capital investment of Rs. 15 lakhs is now before the Planning Commission.

Indiscriminate Use of Aluminium Scrap—The use of aircraft aluminium scrap, containing injurious alloying elements, for the manufacture of kitchen-ware has assumed alarming proportions. The committee took note of the harmful effects of such use on the health of the people and recommended to the Government that the indiscriminate use of aircraft scrap should be banned.

Among other recommendations of the Metals Research Committee to the Government, the following may be mentioned: the need for limiting exports of high grade manganese and chromite ores; and formation of a research association for the metallurgical industry.

As a result of the committee's work active schools of metallurgical research are being developed at Banaras, Bangalore, Calcutta and Bombay. Research work on silicon-copper bronze has shown that this can be used in preference to phosphor bronze for the manufacture of coupling rod bushes for the railways. Production of high purity manganese and its use in special steel in place of nickel have been demonstrated. Valuable work has been carried out on grain size control.

Twenty-four schemes have been sponsored so far.

The following eleven research schemes are under investigation:

1. Aluminium coating of steel—DR. BRAHM PRAKASH, Indian Institute of Science, Bangalore
2. Gases in steel—DR. G. P. CHATTERJEE, Bengal Engineering College, Sibpur, Howrah
3. Mineragraphic study of polished section of opaque ore minerals—PROF. N. N. CHATTERJEE, Presidency College, Calcutta
4. Studies on the corrosion of metals and alloys with special reference to the effect of titanium—DR. G. P. CHATTERJEE and DR. B. CHATTERJEE, Bengal Engineering College, Sibpur, Howrah
5. Studies on binary and ternary alloy systems with titanium as one of the alloying constituents—DR. G. P. CHATTERJEE and DR. B. CHATTERJEE, Bengal Engineering College, Sibpur, Howrah
6. Electro-refining and recovery of copper from scrap—MR. G. C. MITTER, Government of India Mint, Bombay
7. Production of aluminium metal by the electrolysis of molten anhydrous aluminium chloride—DR. E. G. RAMACHANDRAN, Indian Institute of Science, Bangalore
8. Electrolytic manganese as an alloying element in steel—DR. H. SCHRADER, *Tata Iron & Steel Co. Ltd.*, Jamshedpur
9. Modified aluminothermy—DR. D. SWARUP, Banaras Hindu University, Banaras

10. Preparation and properties of high purity titanium metal — DR. D. SWARUP, Banaras Hindu University, Banaras
11. Electro-polishing of bearing surfaces — Director, C.E.C.R.I., Karaikudi

Five papers have been published and five patents taken out.

Glass & Refractories Research Committee

THE Glass & Refractories Research Committee was constituted in 1940, under the chairmanship of Dr. A. Nadel. Mr. M. G. Bhagat, Dr. D. N. Wadia and Mr. D. N. Sen have been the successive chairmen of the committee. Mr. D. N. Sen is the chairman of the committee at present.

The scope and functions of the committee are:

1. Development of fundamental and applied research having a bearing on different branches of glass and ceramics;
2. to initiate survey of raw materials for the glass and ceramic industries;
3. to initiate, organize and co-ordinate research on a planned basis; and
4. collection of data and dissemination of technical information to industry.

The committee recommended, at its first meeting, the establishment of a central institute for research in glass. The views of the industry with regard to research were collected through a questionnaire, and in 1944, the committee modified its recommendations and proposed that a Central Glass & Ceramic Research Institute should be established. The committee further suggested that a survey of raw materials for glass and ceramic industries should be taken up, and that a sand washing plant should be installed at the proposed institute.

SURVEY OF RAW MATERIALS

The committee initiated an extensive survey of the glass and ceramic raw materials available in the country. Field work relating to the survey was undertaken by the Geological Survey of India. About seven hundred samples of clays have been collected from different areas and a detailed study of the composition and properties of the samples has been taken up at the Central Glass & Ceramic Research Institute, Calcutta. Intensive examination of the more promising deposits is also in progress.

A detailed survey of clay deposits which are now being worked in the country has also been undertaken. The Rajmahal and Travancore clay deposits are now being examined by the Geological Survey of India. A systematic survey of talcs available in the country has also been started. Collected samples are being studied at the Central Glass & Ceramic Research Institute.

A monograph embodying the results of the surveys will be published in the near future.

PRODUCTION OF OPTICAL GLASS

At the instance of the committee investigations on optical glass were started in 1941 at the Foreman Christian College, Lahore. The reports were lost during the disturbances in 1947.

The committee has urged upon the Government the need for setting up a unit for the production of optical glass. A scheme prepared by the Director of the Central Glass & Ceramic Research Institute was considered by the committee, and recommended to the Government. It is understood that the Government have decided to set up a factory in Calcutta.

HAEMATOLOGICAL INSTRUMENTS

In pursuance of the recommendation of the Indian Council of Medical Research, the Glass & Refractories Research Committee initiated investigations on the manufacture and standardization of haematological instruments. Detailed specifications were provided to a firm in Calcutta. The instruments have since been produced according to the specifications and they have been tested at the School of Tropical Medicine, Calcutta. Work on the standardization of the instruments is under progress.

Fourteen research schemes have been sponsored so far.

The following research schemes are in progress:

1. Critical examination of the use of nepheline syenite available in India for use in glass factories — DR. R. CHARAN, Banaras Hindu University, Banaras
2. Studies of the refractory and ceramic properties of Indian pyrophyllite — DR. M. L. MISRA, Banaras Hindu University, Banaras
3. Investigations on the critical condition of producing plaster of Paris suitable for making moulds of potteries from gypsum available in the country and utilization of waste plaster of Paris moulds — PROF. H. N. RAY, Banaras Hindu University, Banaras
4. X-ray studies of Indian clays — SULTANA Z. ALL, Central Laboratories for Scientific & Industrial Research, Hyderabad

Three papers have been published.

Salt Research Committee

THE Salt Research Committee was constituted in November 1940, at the instance of the Director, Scientific & Industrial Research, to formulate a programme of research on problems relating to the utilization of naturally occurring salts. Dr. H. B. Dunnichiff was its first chairman. Dr. Sir Cyril S. Fox acted as chairman during the period 1941-44.

The committee considered in detail the salt resources in various States and prepared a comprehensive report on the national salt resources. The committee also made suggestions on the manufacture of (1) ammonium chloride by burning village refuse; (2) sodium carbonate and sodium sulphate from naturally occurring deposits like *reh* and *sajji*; and (3) salt from Khewra Salt Range, and sea and subterranean salt works in Bombay and Madras States. A scheme for the production of high purity salt was formulated.

The Salt Research Committee of the Government of India submitted an interim report in June 1948, in which the need for scientific research on a number of problems pertaining to the development of the salt industry in India was emphasized. Research on the problems had to be indicated and the Council revived the Salt Research Committee in July 1948, with Dr. Mata Prasad as chairman. The following functions were assigned to the committee:

1. To examine the present methods of production of salt and suggest improvements thereon with the object of stepping up production of salt in India for domestic as well as industrial uses;
2. to fix standards of purity of salt for use in different industries and to suggest and work out methods of purification;
3. to explore natural deposits of salt, such as those occurring in Rajasthan, and to suggest means for their beneficiation;
4. to find out suitable methods of making salt on a small scale so that people who are near the sea and the salt deposits could make salt;
5. to investigate the nature of byproducts obtained in the manufacture of salt and work out methods for their separation;
6. to investigate the utilization of various salts from sea water for making chemicals; and
7. to undertake investigations and to recommend the institution of schemes of research in furtherance of the above objectives and to co-ordinate the research work.

MODEL SALT FARM

The committee undertook a survey of the methods of salt manufacture in various parts of the country, with particular reference to the quality of salt produced. Defective layout of salt works and unscientific methods of manufacture were largely responsible for the poor quality of salt obtained. The committee recommended that the Government of India should take steps to establish model salt farms and research stations at various centres in the country to (1) demonstrate to salt manufacturers the methods of improving the quality of salt and (2) conduct investigations on (a) the economic size of pans and other factors influencing salt production and (b) utilization of bitterns.

The recommendations were accepted and the Government of India established a salt farm and research station at Wadala, Bombay, in November 1949. The research station has been functioning under the technical guidance of the Salt Research Committee. By redesigning the layout of salt pans and introducing necessary changes in the method of manufacture, edible salt of 98 per cent purity has been produced without adding to the production cost. Several salt manufacturers in Bombay have agreed to adopt the improved technique.

On the basis of the experience gained in running the Wadala farm, the Salt Research Committee has recommended that the Government Salt Factory at Levingipuram, Madras, which has been leased out to private manufacturers, should, on the expiry of the present lease, be taken over and run by the Government on departmental basis as a model salt farm for South India and a research station be attached to it. The establishment

of a model salt farm in Travancore has also been recommended. At the instance of the committee, the Geological Survey of India has surveyed the Sultanpur area. Samples of brine collected from the area are being analysed and it is proposed to open a salt factory in the area.

STANDARD OF PURITY

The committee is of the opinion that for effecting improvements in the quality of salt, strict enforcement of standards of purity is necessary. The committee has assisted the Indian Standards Institution in drawing up specifications for edible salt. A tentative standard of 96 per cent has now been fixed and the committee has recommended that the Salt Controller should take steps to ensure that the salt produced attains the specified standard within a period of three years, and the Indian Standards Institution should be requested to revise the specification later. Data relating to salt required for curing fish and for curing hides and skins have also been collected and a draft standard specification for salt used for these purposes is being prepared.

Another impediment to the production of high purity salt is the prevailing practice of selling salt by measure instead of by weight. This practice serves as an inducement for the production of light salt. The committee has recommended that State Governments should take steps to ban the sale of salt by measure. The Bombay Government have already taken steps to ban the salt sale by measure and the Madras and Travancore-Cochin Governments have proposed similar legislation.

The recovery of byproducts from bitters is important not only from the point of view of byproduct chemicals but also for improving the quality of salt. The committee has prepared a note entitled "Recovery of Byproducts in Salt Manufacture from Sea and Subsoil Brine" and circulated it to salt manufacturers in India.

At the request of the committee the National Chemical Laboratory has developed a method for preparing a mixed fertilizer by ammoniating sea bitters. A quick method for the assay of the purity of common salt has been developed at the National Chemical Laboratory. This method can be adopted by small manufacturers without undue expenditure on laboratory facilities or on qualified personnel.

At the instance of the Salt Research Committee, the National Chemical Laboratory has completed laboratory scale investigation on the preparation of magnesium oxychloride cement from commercial magnesium chloride.

At the instance of the Chief Commissioner, Kutch, the committee surveyed the salt resources in selected areas in the Ran of Kutch. The survey revealed the occurrence of deposits of high quality salt but their commercial exploitation was not feasible for lack of transport facilities.

The committee recommended to the Government that administrative difficulties which stand in the way of better utilization of Kharagoda bitters should be removed.

CENTRAL SALT RESEARCH STATION

The Salt Experts Committee of the Government had recommended the establishment of seven model salt farms — one each in the chief salt-

producing areas—in Bombay, Travancore and Madras, and one at Sambhar. While generally agreeing with this recommendation, the Salt Research Committee considered that the utilization of byproducts of the Sambhar Lake required immediate attention and a draft plan was prepared for the establishment of a research station at Sambhar Lake. In the meanwhile, the Government of Saurashtra offered building and other facilities for the establishment of a Salt Research Station at Bhavnagar. The Government of India decided to accept this offer and the Council was requested to set up a Central Salt Research Station at Bhavnagar. The building presented by the Saurashtra Government was taken over by the Council and necessary alterations have been effected for adapting it to the needs of a research laboratory.

In August 1952, the committee appointed a subcommittee to visit Bhavnagar and select a site for the proposed model salt farm and field laboratory. The subcommittee also made recommendations with regard to divisions, staff, etc., for the Central Salt Research Station. According to these recommendations the station would consist of three Divisions, a Model Salt Farm, a Field Laboratory and a Pilot Plant Section.

Vegetable Oils Research Committee

THE Vegetable Oils Research Committee was set up in 1940, when, due to the stoppage of exports of oils and oilseeds, there was an urgency for finding alternative uses for these raw materials. Dr. S. S. Bhatnagar was the chairman of the committee.

Mr. P. A. Narielwala, Dr. M. Qureshi, Dr. S. Siddiqui, and Prof. J. W. McBain have acted as chairmen of this committee. The present chairman is Prof. T. R. Seshadri.

The committee surveyed the possibilities and instituted investigations on problems including the use of vegetable oils as fuels for internal combustion engines and as lubricants. The utilization of groundnuts and groundnut oil demanded immediate attention and the Government of India made a special grant of Rs. 2 lakhs for investigations on this subject in the D.S.I.R.'s laboratories.

The objectives of the committee underwent a complete change on the termination of the war. Vegetable oils became scarce and the resources were insufficient to meet even the internal demands. The emphasis in the activities of the committee shifted to the discovery of alternative and new sources of vegetable oils required to meet the requirements of various industries. The committee recommended to the Central and State Governments that the cultivation of oilseed-bearing plants should be encouraged. A note on the collection and cultivation of secondary sources of oilseeds was prepared and circulated. A survey of these resources was recommended. Research schemes for the utilization of *kamala* seed oil and tobacco seed oil and for finding substitutes for coconut oil for use in soap manufacture were sponsored.

CENTRAL OILSEEDS COMMITTEE

The Government of India set up in 1945 the Central Oilseeds Committee, financed by the levy of a cess on oilseeds crushed in India, for the development of the Indian oilseeds industry. The committee was asked

to consider and initiate measures for improvement of the production and the marketing of oilseeds, development of the village oilseeds crushing industry, and promotion of technological research on the utilization of vegetable oils. The Council collaborates with the Central Oilseeds Committee in the investigation of problems on the technology of oils, and the programme of research on vegetable oils at the National Chemical Laboratory, Poona, is being partly financed by the Central Oilseeds Committee. A representative of the Vegetable Oils Research Committee is a member of the Technological Subcommittee of the Central Oilseeds Committee and vice versa. A representative of the latter committee is a member of the CSIR Vegetable Oils Research Committee.

A proposal for the establishment of a central institute for oil technology was considered but not accepted by the committee as there were already a large number of active centres of research in various parts of the country. The committee felt that the facilities available at present should be utilized for furthering research on vegetable oils. The National Chemical Laboratory was recognized as one of the major centres for research in oil technology.

Anti-gas varnish compositions for the manufacture of anti-gas cloth, utilization of vegetable oils as lubricants, dehydration of castor oil and its use as a substitute for tung oil are some of the notable results of sponsored research carried out under this committee. Survey and utilization of the secondary resources of vegetable oils are now receiving attention.

Ten schemes have been sponsored so far.

The following research schemes are being pursued:

1. Modification of mowrah fat — DR. J. G. KANE, Department of Chemical Technology, Bombay University, Bombay
2. Stability and component fatty acids in hydrogenated fats — DR. N. G. MAGAR, Institute of Science, Bombay

Twelve papers have been published and nine patents taken out.

Vanaspati Research Advisory Committee

THE Vanaspati Research Advisory Committee was constituted in October 1947 for formulating plans and organizing research for the vanaspati industry. The Vanaspati Manufacturers' Association of India has been making an unconditional annual grant towards the expenses incurred in implementing the research programme. Dr. S. S. Bhatnagar is the chairman of the committee.

COLOURIZATION OF VANASPATI

The problem of adulteration of ghee with vanaspati and the measures to be taken for preventing the adulteration was discussed at a joint meeting of the Nutrition Advisory Committee of the Indian Council of Medical Research and the Vanaspati Research Advisory Committee of the Council of Scientific & Industrial Research on 23 November 1949. It was pointed out that (1) no satisfactory dye was known for the colourization of vanaspati and (2) a rational approach to the problem of adulteration in ghee was to modify the existing regulations governing the adulteration of foodstuffs and to enforce regulations more vigorously.

The joint committee was of the opinion that the public was not correctly informed about edible oils and fats and about the effect of processing on their nutritive value. The joint committee recommended the formation of a subcommittee with the following terms of reference: (1) to collect up-to-date scientific information on edible fats and oils and the effect of processing on them; (2) to keep abreast of oil developments in the subject, specially in respect of hydrogenated fats and oils, not only in India but also in other countries; and (3) to keep a watch on public opinion with regard to edible oils and fats and to advise on matters relating to adulteration, etc., as and when a reference is made. This subcommittee was expected to report to the Indian Council of Medical Research and the Council of Scientific & Industrial Research through the Nutrition Advisory Committee and the Vanaspati Research Advisory Committee respectively. It was also decided that the organizations should take steps to keep the Government fully and correctly informed on these matters.

As per decision of the joint subcommittee, *Literature Reviews on Fats & Oils (Edible & Hydrogenated)* for 1949 and 1950 have been published.

The joint subcommittee was dissolved in 1951. The Vanaspati Research Advisory Committee has prepared literature reviews for 1951 and 1952.

MONOGRAPH ON VANASPATI

Experiments on the nutritive values of vegetable oils, hydrogenated oil, and butter fat were planned and carried out under the auspices of the Technical Panel of the Ministry of Food. These experiments were divided into three parts: (1) animal experiments; (2) human metabolism studies; and (3) institution feeding experiments. The following conclusions were drawn from the experimental results.

(1) In comparative feeding experiments carried out at four different research centres on rats for three generations with raw groundnut oil, refined groundnut oil and vanaspati of m.p. 37° and 41°C., there is no deleterious effect produced by vanaspati as compared with raw unrefined oil;

(2) human feeding trials carried out at four different centres also indicated that vanaspati of m.p. 37°C. has no harmful effect as compared with raw groundnut oil;

(3) feeding experiments with poor rice diets have not shown vanaspati of m.p. 37°C. to have any deleterious effect as compared with raw and refined groundnut oil. Vanaspati of m.p. 41°C. appears to be less absorbed than raw groundnut oil and may have an adverse effect on calcium utilization; and

(4) the balance of experimental evidence indicates that ghee is the best from the nutritive point of view followed by raw groundnut oil, refined groundnut oil and vanaspati of m.p. 37°C.

With the concurrence of the Ministry of Food the results of the investigations have been published in the form of a monograph entitled *Composition & Nutritive Value of Vanaspati*.

Six schemes have been sponsored by the committee.

The following research schemes are in progress:

1. Stability of crude, refined and hydrogenated oils — DR. B. C. GUHA, University College of Science, Calcutta

2. Studies on iso-oleic acids — Dr. V. N. PATWARDHAN, Nulbari Research Institute, Coonoor

3. Processing and utilization of cottonseed oil — Dr. V. SUBRAMANYAN, Central Food Technological Research Institute, Mysore

Eight papers have been published.

Essential Oils Research Committee

ON the recommendation of the Vegetable Oils Research Committee of the Council, an Exploratory Committee for Essential Oils was set up by the Government of India in November 1940. The exploratory committee undertook a survey of the Indian essential oil industry and recommended that the following steps should be taken to further the growth and development of the industry on proper lines:

1. To investigate the possibilities of growing aromatic grasses, plants and trees in different parts of India as a secondary crop;
2. to prepare a botanical list of the existing aromatic trees, plants and grasses, whether cultivated or growing wild in the country, together with areas covered by them and the approximate quantities available;
3. to create an Essential Oils Advisory Committee to advise the Board of Scientific & Industrial Research regarding the ways and means of developing the industry. The advisory committee should be entrusted with the following functions: (a) *Exploratory* — Investigation of the economic and commercial aspects of developing new essential oils in the country; (b) *Research*: (i) systematic study of all aromatic grasses, plants, trees, flowers, roots, seeds, etc., growing in India with a view to determining their aromatic constituents and their properties; (ii) setting up of a central laboratory to carry out the programme of work laid down by the advisory committee; (c) *Commercial utilization* of the results of research; and (d) *Co-ordination* — to bring about co-ordination between various Government departments, research institutions and industries engaged in work on various aspects of essential oils and to help in proper allocation of research problems at institutions where necessary facilities exist.

The recommendation regarding the setting up of the Essential Oils Advisory Committee was accepted by the Board and a committee was set up with Mr. P. A. Narielwala as chairman. The name of the committee was later changed to the Essential Oils Research Committee. Mr. A. K. Menon is the present chairman.

RECOMMENDATIONS

On the recommendation of the committee, trial cultivation of palmarosa was undertaken in Bombay State and of patchouli in Madhya Pradesh. The Government of Rajasthan made a grant of Rs. 15,000 for the development of khus industry in Bharatpur.

The Government of Travancore-Cochin have decided to set up a laboratory for assisting the development of the lemongrass oil industry.

PAST VICE-PRESIDENTS, C.S.I.R.



SHRI A. HYDARI
(1943-46)



DR. SVAMA PRASAD MOOKERJEE
(1947-50)



SHRI HAREKRUSHNA MAHTAB
(1950-51)



SHRI SRI PRAKASA
(1951-52)

The Government of Madras are taking steps to develop the cultivation of geranium and vetiver in the State.

The committee recommended that a co-ordinated programme of work should be prepared and problems should be allocated to laboratories best suited to handle them. The committee suggested that the Forest Research Institute should concentrate on naturally occurring sources of essential oils and the National Chemical Laboratory on synthetics and semi-synthetics. It was further suggested that investigations on essential oil-bearing grasses of the *Cymbopogon* species should be taken up at the Central Research Laboratory, Travancore; essential oils from peels, leaves and flowers of citrus species at the Central Food Technological Research Institute, Mysore; investigations on the development of rose oil industry at the Harcourt Butler Technological Institute, Kanpur; work on the development of patchouli and cananga at the Indian Institute of Science, Bangalore; and on cananga at the Forest Research Institute, Dehra Dun.

The following problems have been referred to the National Chemical Laboratory, Poona, and the Forest Research Institute, Dehra Dun, for investigation:

National Chemical Laboratory, Poona — (a) Utilization of terpene fractions of ajowan oil; (b) *Mentha viridis*; (c) vitamin A from β -ionone; (d) borneol acetate from turpentine.

Forest Research Institute, Dehra Dun — (a) *Chenopodium ambrosioides* Linn.; (b) *Mentha piperita*; (c) survey of *Pinus* species; (d) *Chua* oil.

On the recommendation of the committee, the Council is making efforts to obtain linaloe seeds from Mexico.

SURVEY OF AROMATIC PLANTS

The committee has initiated comprehensive surveys on khus, jasmine, rose, palmarosa, citrus, patchouli, camphor, lemongrass and cloves.

Twenty schemes have been sponsored by the committee.

The following scheme is in progress:

Cultural experiments on patchouli — MR. B. S. NIRODY, Indian Institute of Science, Bangalore

Eleven papers have been published.

Plastics Research Committee

THE Plastics Research Committee was set up in July 1940, with Dr. S. S. Bhatnagar as chairman. Dr. J. C. Ghosh took over the chairmanship in 1944, while the present chairman, Dr. L. C. Verman, assumed charge in 1950.

The results of research work sponsored by the committee during the war period met with immediate acceptance in the industry because of the pressing need to utilize, as far as possible, indigenous materials. But after the war, overseas raw materials were readily available and plastics could be produced at cheaper rates. There were also no organized industries to exploit the local raw materials. This led to a reorientation of the needs of research and emphasis shifted towards theoretical researches. During the last few years research schemes for the construc-

tion of delicate instruments used in the study of macro-molecules came to the fore and are being successfully worked out.

With the development programme now being pursued by the Government of India, the needs of research are again assuming a different character. It is, therefore, more imperative now to have a co-ordinate programme of research. The committee had envisaged the need for such a planned programme of research as long ago as 1946, when a survey and compilation of research problems in plastics, with special emphasis on the utilization of indigenous raw materials, was prepared at the instance of the committee by Dr. Lal C. Verman with the assistance of Dr. A. Jogarao. However, due to various reasons, this survey could not be published earlier. This survey has been revised and the revised survey is now under publication. The problems suggested in it will be implemented in the near future.

The committee has also contributed in other ways to the progress of research on plastics in India. For instance, when the National Chemical Laboratory of India was being planned, the committee made a recommendation that a division of high polymers should also be established. This recommendation has been implemented.

As research workers in India found considerable difficulty in obtaining monomers, the committee made exhaustive enquiries regarding the quantities of monomers required by various research institutions. On the recommendation of the committee, the Council has obtained large supplies of monomers such as methyl methacrylate, vinyl acetate, styrene, allyl acetate, etc. The monomers are kept in the National Chemical Laboratory, Poona, and are made available for research purposes to research institutions and scientists.

A large number of urgent practical problems in respect of war supplies were tackled in the departmental research schemes sponsored by the committee in the Delhi laboratories of the C.S.I.R. The products which were successfully developed are: Jettison tanks, plastic containers, collapsible tubes, petrol-proof canvas bags, bullet-proof tanks, impregnated ropes and planks for various uses, laminated and corrugated boards, varnishes and enamels using indigenous resins such as bhilawan shell liquid and cashew-nut shell liquid, shellac aeroplane dopes, plywood adhesives, water, fire, petrol and oil-proof compositions, impregnating compositions for textile mill bobbins, cork substitutes, petrol pump diaphragm and petrol hose, shock-absorbing material using coir, and moulding compositions from indigenous materials.

Twelve schemes have been sponsored so far.

The following research schemes are being pursued:

1. Construction of osmometers suitable for high polymer research — DR. S. R. PALIT, Indian Association for the Cultivation of Science, Calcutta
2. Construction of a light scattering apparatus for the measurement of molecular weight, size and shape of light polymers — DR. S. R. PALIT, Indian Association for the Cultivation of Science, Calcutta
3. Studies on thermodynamic properties of high polymer solutions — DR. S. R. PALIT, Indian Association for the Cultivation of Science, Calcutta

Forty-two papers have been published and forty-seven patents taken out.

Cellulose Research Committee

THE cellulose Research Committee was constituted in 1940, under the chairmanship of Lala Shri Ram. Dr. Nazir Ahmad, Dr. S. Krishna and Dr. Lavji Thoria have acted as chairmen of this committee in succession. The present chairman is Dr. B. K. Vaidya of the Ahmedabad Textile Industry Research Association, Ahmedabad.

The committee was set up with the primary object of initiating research on raw materials for the manufacture of rayon and to take steps for the establishment of a rayon industry in India. Later, the scope of the committee was extended to include fundamental and applied investigations on all aspects of cellulose and related materials.

SUITABLE SITES FOR RAYON FACTORIES

At the instance of the committee, Dr. Lavji Thoria surveyed the suitability of various localities in India for the establishment of rayon factories. The survey, a report on which has been published, revealed that Alwaye in Travancore, Kalyan in Bombay and Navsari in Baroda provided suitable sites for the location of the rayon industry. Proposals for starting three rayon factories based on the viscose process, one each in Travancore, Bombay and Baroda, were made in 1942.

The Council has obtained a pilot plant for the production of chemical cotton for evaluating the suitability of linters and other indigenous cellulosic raw materials for rayon manufacture. This plant has now been set up in the National Chemical Laboratory, Poona.

CELLULOSIC RESOURCES

A survey of cellulosic resources of India has been carried out by the Central Cotton Technology Laboratory at Bombay. The survey has indicated that bamboo, eetta reeds and bagasse are valuable sources of α -cellulose. A scheme carried out at the Forest Research Institute has resulted in the development of a process for manufacturing paper pulp by semi-mechanical means from bamboo and bagasse. A study of linters from different varieties of cotton grown in India is being made by the Central Cotton Technology Laboratory at the instance of the committee.

Four research schemes have been sponsored.

The following scheme is in progress:

Anatomical study of cellulosic raw materials — DR. K. A. CHAUDHURY & DR. R. V. BHATT, Forest Research Institute, Dehra Dun

Five papers have been published and one patent taken out.

Leather Research Committee

THE Leather Research Committee was constituted in 1944 on the basis of a recommendation passed at a conference held in 1943 under the auspices of the Department of Industries & Civil Supplies, with Mr. B. M. Das as chairman,

The committee adopted a programme of leather research covering about thirty problems with special emphasis on the utilization of indigenous tanstuffs. These problems were to be investigated in different tanning institutes in India. A special grant was recommended for long-range research in the Bengal Tanning Institute. The committee also recommended the establishment of a Central Leather Research Institute at Madras, for which a plan was prepared by Mr. B. M. Das and (late) Mr. K. Seshachalam Choudhry. An important part of the plan was the setting up of a full-sized tannery as an adjunct to the research departments.

RECOMMENDATIONS

The committee was aware, since its inception, of the importance of taking measures for consolidating and expanding the tanstuff resources of India. With this end in view, the committee recommended that a detailed survey of vegetable tanstuffs available in India should be undertaken by the Forest Research Institute, Dehra Dun. The committee also urged upon State Governments to take steps to increase the cultivation of wattle, avaram and babul, so that sufficient quantities of vegetable tanning materials may become available for the indigenous leather industry. A number of States, e.g. Madras, Bengal, etc., adopted intensive and concerted measures for developing the tanstuff resources. Cultivation of wattle on a plantation scale was taken up in Madras. The Government of Punjab was requested to ban the use of babul bark as fuel by the rural population.

On the recommendation of the committee, the Indian Veterinary Research Institute, Muktesar, took up investigations on the defects of raw hides and skins and the methods of overcoming them. The committee suggested to the Ministry of Agriculture that steps should be taken to encourage the cultivation of *Deris* in the States with seeds imported from Malaya.

The possibilities of developing a new type of flaying knife were explored by the committee and a scheme was drawn up for training skilled flayers. The Veterinary Department of the West Bengal Government started a training course and imparted training to flayers drawn from different States.

An annual block grant of Rs. 60,000 was made to the University of Madras, for three years, towards the establishment of a Department of Leather Technology. When the Central Leather Research institute was established, the facilities of the institute were made available to the university for training students in leather technology.

A joint meeting of the Leather Research Committee and the Planning Committee of the Central Leather Research Institute was held at the time of the opening of the institute, and programmes of long-range and short-term research to be taken up at the institute were formulated. The committee is now considering details of a programme of collaborative research in which the Central Leather Research Institute, regional tanning institutes, and other research establishments in India, such as the Forest Research Institute, Dehra Dun, can participate.

Eight schemes have been sponsored by the committee.

The following research schemes are in progress:

1. Investigation of mangrove swamps of the Sunderbans, especially of goran — MR. M. BANERJEE, Bengal Tanning Institute, Calcutta

2. Research on the manufacture of upholstery and other special types of leather — MR. B. M. BANERJEE, Bengal Tanning Institute, Calcutta
3. Microscopic data and standard specifications for V.T. sole leather — MR. B. M. BANERJEE, Bengal Tanning Institute, Calcutta
4. Physico-chemical properties of tanned and untanned hides — DR. B. N. GHOSH, University College of Science, Calcutta

Two patents have been taken out.

Atomic Research Committee

THE Board of Scientific & Industrial Research appointed the Atomic Research Committee, with Dr. H. J. Bhabha as chairman, in January 1946. The committee urged upon the Government of India to ban the export of monazite from Travancore and recommended that the processing of monazite should be undertaken in India. The committee also recommended that the export of beryllium ore should be banned. Two subcommittees were appointed to survey the uranium and thorium resources of Travancore and other parts of the country. On the recommendation of the committee the Geological Survey of India established a special unit for the purpose.

The committee recommended the setting up of a high energy accelerator and a small betatron at the Tata Institute of Fundamental Research, Bombay. It was accepted that the Tata Institute of Fundamental Research should be developed as the chief centre for work on atomic energy. A grant was made to the institute for training ten scientists for research in nuclear physics. A grant was also made to Dr. D. M. Bose, Bose Institute, Calcutta, for research on transuranic elements. A block grant of Rs. 1,10,000 was given to the Calcutta University for setting up a cyclotron laboratory. A research scheme was started at the Cancer Research Hospital, Bombay, on the biological aspects of atomic energy.

In June 1947 the Council decided to expand the scope of the Atomic Research Committee and constituted the Board of Research on Atomic Energy with the following functions:

1. To plan, finance and carry out atomic research and development throughout India;
2. to explore the availability of raw materials connected with the generation of atomic energy in India and to advise the Government on the control, utilization and export of such raw materials;
3. to provide the machinery for co-operation in matters of atomic energy, research and development with corresponding bodies and to advise the Government on any agreements with foreign powers that may be necessary for the purpose; and
4. to appoint committees and take all other steps in furtherance of the aim of developing atomic research and energy to the fullest extent in India.

A joint committee with representatives of the Government of Travancore-Cochin was also set up for the development of atomic energy minerals in the State. This committee was recognized by the Government of Travancore-Cochin as the sole advisory body in all matters pertaining to the

development of atomic energy and research including the utilization of radioactive raw materials.

On the creation of the Department of Scientific Research in 1948 the Atomic Energy Commission was set up and the Board of Research on Atomic Energy was transferred to that department.

Special Committees

SPECIAL committees have been appointed from time to time by the Board of Scientific & Industrial Research to examine specific problems and formulate recommendations for the consideration of the Board. The work of some of the committees is briefly described below.

SYNTHETIC PETROL

The Board set up a committee in 1948, with Dr. J. C. Ghosh as convener, to outline a scheme for the manufacture of liquid fuel from coal. The committee invited foreign experts to survey the possibilities. Three project reports were received for the consideration of the committee. These were:

1. *Koppers Corporation Inc.*, Pittsburgh, U.S.A. — A synthetic petrol plant consisting of (a) a low temperature coal carbonization unit and (b) a tar hydrogenation unit for the manufacture of aviation petrol, motor petrol, and domestic coke at a cost of Rs. 31.6 crores.
2. *Ruhr-Chemie-Lurgi*, Germany — A synthetic petrol plant based on Fischer-Tropsch synthesis for the manufacture of aviation gasoline, motor gasoline and diesel oil at a capital investment of 58 million dollars.
3. *J. W. Kellogg Company*, U.S.A. — Setting up a refinery of one million ton annual capacity to produce aviation gasoline, motor gasoline and other petroleum products (kerosene, diesel oil, furnace oil, etc.) from imported crude petroleum at a capital cost of 20.8 million dollars.

The committee considered the merits of schemes for the manufacture of synthetic oil from Indian coal *vis-à-vis* the project for setting up a refinery plant, and recommended the immediate establishment of a refinery with sufficient storage capacity. The committee recommended, as a long-term measure, the planning and erection of a synthetic petrol plant.

The first recommendation has since been implemented. Three oil refineries (two on the west coast and one on the east coast) with a total annual capacity of 3.4 million tons of refined products are being established. Fresh project reports for the production of petrol from coal, incorporating the most recent developments in U.S.A. and Germany, are now being obtained by Government and the possibilities for producing liquid fuel from coal will be re-examined.

POWER ALCOHOL FROM BAGASSE

A committee under the chairmanship of Lala Shri Ram was set up in 1948 to examine a proposal for the manufacture of power alcohol from

bagasse and other cellulosic raw materials. Pilot plant investigations were sponsored by the committee to examine the economic aspects of alcohol production from bagasse.

A 60 per cent conversion of bagasse to reducing sugars was obtained by using concentrated or dilute sulphuric acid. By fermenting the hydrolysate, a yield of 1.3 gallons of alcohol was obtained from 100 lb. of bagasse and the cost of alcohol worked out to Rs. 2/12/- per gallon.

To reduce the cost of production, it would be necessary to utilize the byproducts (xylose, lignin, etc.). Without developing such uses for the byproducts, it would be uneconomical to produce power alcohol from bagasse.

The importance of the problem was stressed at the United Nations Seminar on Power Alcohol held in 1952 at Lucknow under the joint auspices of the ECAFE and the Government of India.

RESEARCH & DEVELOPMENT OF GAS TURBINE & JET PROPULSION ENGINES IN INDIA

In March 1953 a committee, with Mr. J. R. D. Tata as chairman, was appointed to consider and report on the subject of research, development and manufacture of gas turbine and jet propulsion engines in India. The committee has directed attention to the following aspects of the subject:

1. Whether a programme of research in the design and development of gas turbine engines should be undertaken in India, and if so, the nature of such research and the field to be covered;
2. research work done in India up to the present and whether such work should be continued and financially supported;
3. if research and development is to be undertaken, whether it should be sponsored in existing establishments or new establishments should be created for the purpose, or both; if a new gas turbine research establishment is indicated, to make specific recommendations;
4. capital and recurring requirements and the availability and source of funds for the purpose; and
5. whether the manufacture of gas turbine engines should be undertaken in India; if so, the manufacturing agency to undertake it.

Steps have been taken to obtain the services of an expert from U.K. to assist the committee in its work.

LOW COST HOUSING

A committee to examine the subject of housing was appointed in March 1952 with the following terms of reference:

1. To study and analyse scientifically the basic minimum requirements of habitation in various parts of India;
2. to undertake a scientific study of the problem of housing both from the short and long-term points of view; and
3. to submit a report and make recommendations to Government on (1) and (2) above.

The committee submitted a report in November 1952, containing the following recommendations:

1. A start should be made for the improvement of rural housing by putting up model houses.
2. In towns and cities, a room of about 120 sq. ft. and a verandah of about 80 sq. ft. with provision for a cooking chimney in one corner is all the built-in accommodation which should be aimed at for lower income groups at present. Each house should, however, have an area of 60-100 sq. yards enclosed by a wall or a hedge.
3. The manufacture of lime from kankar and limestone, where these are available in adequate quantities, should be encouraged and the use of lime in building work popularized.
4. Considerable work has been done on soil stabilization, rain-proof mud plasters, etc. This work should be utilized in actual practice.
5. The truncated cone shaped hollow tile construction used in Hyderabad should be given an extended trial so that its defects and advantages could be fully judged.
6. The greatest possible advantage should be taken of such innovations as pre-stressed concrete by organizing publicity and demonstrations.
7. The Indian Standards Institution, the Central Building Research Institute and similar other institutions should undertake necessary enquiries to enable them to prescribe national standards in respect of building materials, equipment and components for use in construction work.
8. A central organization with regional departments should be established to stock tools and machines for building construction.
9. Mechanical devices should be adopted wherever they are found cheap and efficient and where existing labour is incapable of doing a particular work efficiently or cheaply.
10. The Council of Scientific & Industrial Research should examine the possibility of instituting a co-ordinated programme of research embracing problems of design, functional and operational requirements of buildings, basic studies of structures, nature and properties of clays, minerals and soils. Reliable surveys should also be carried out to determine the performance of existing materials and equipment.
11. In addition to the organization of building research on a central and regional basis, it is desirable that the results of such research should be duly co-ordinated and publicized to all building agencies both under public and private control.
12. Emphasis should be placed on functional or performance standards rather than on rigid specifications based on the quantity or volume of individual materials.
13. All obstacles or restrictions to the free transport of building materials should be abolished.
14. The committee considers that a *Central Town and Country Planning Act* should be passed to enable systematic improvement and reconstruction of existing and future towns.

These recommendations were conveyed to the Government of India for consideration by the proposed National Building Organization and the National Housing Board.

THIRD INTERNATIONAL GEOPHYSICAL (POLAR) YEAR, 1957-58

The General Assembly of the International Council of Scientific Unions has set up a special committee for organizing the Third International Geophysical Year in 1957-58 with the object of obtaining as complete a picture as possible of various atmospheric phenomena and processes. The programme of observations covering fields such as solar physics, terrestrial magnetism, atmospheric electricity, meteorology, ionosphere, cosmic rays, atmospheric ozone, etc., will be carried out during that year in various countries according to the recommendation of a Joint Commission of (i) International Scientific Radio Union, (ii) International Astronomical Union, (iii) International Union of Geodesy & Geophysics, and (iv) International Union of Pure & Applied Physics.

A National Committee to organize a comprehensive programme in all the specified subjects has been formed with Dr. K. S. Krishnan as chairman.

India is co-operating in the general programme in the following main fields: (i) longitude survey, (ii) solar observations, and (iii) ionospheric studies including ionospheric winds.

A tentative programme has been drawn up including the following: (i) high power pulse transmissions in the short-wave band from some of the broadcasting centres; (ii) studies on scattering of very high-frequency radio waves with special reference to propagation; (iii) study of the upper part of the *F* region with the help of galactic radiation; (iv) collection of data on sporadic *E* echoes which will be available from the routine records of ionospheric stations; (v) study of ionospheric absorption; (vi) spectroscopic study of air-glow; an extensive study of the air-glow spectrum, particularly of OH bands; (vii) observations on atmospheric ozone; (viii) magnetic observations; (ix) high level winds, temperatures and humidities; (x) radio astronomy; and (xi) cosmic ray studies.

CALENDAR REFORM

In August 1952 a committee with Prof. M. N. Saha as chairman was appointed to examine the existing calendars followed in India and, after a scientific study of the subject, to submit proposals for an accurate and uniform calendar for the whole of India.

The committee has recommended that a national solar calendar should be compiled and that the lunar calendar, which is essential for religious purposes, should be pegged on to it. A locality 82.5°E. of Greenwich and on the latitude of Ujjain should be selected as the basic latitude and for the location of a Central Astronomical Observatory. The committee has laid down the principles for the compilation of luni-solar calendar for the next five years.

The committee has suggested that steps should be taken to compile an Indian Ephemeris and a nautical almanac for the use of calendar makers, the Navy and the Air Force. The Indian Ephemeris would be a "Source Book" to *panchang* makers and will thus go a long way in providing a uniform and correct *panchang* for the country. The preparation of the almanac would provide most useful training in computational and numerical methods. This will also serve as an essential prelude to the compilation of nautical and air almanacs later.

INSTRUCTIONS FOR THE GUIDANCE OF AUTHORS OF SCIENTIFIC PAPERS

The Royal Society Scientific Conference held in London in 1945 discussed the subject of preparation of scientific communications and came to the conclusion that many defects in scientific articles and delays in publication were due to inadequate preparation of manuscripts submitted to publishing bodies. The conference invited learned bodies to initiate a vigorous and sustained programme to improve the preparation of scientific papers.

A joint committee of the Council and the National Institute of Sciences of India was set up in July 1949, with Dr. S. R. Ranganathan as chairman, to prepare a set of instructions for the guidance of authors of scientific papers. The notes drawn up by the committee, and published in 1951, have helped in the formulation of a standard practice for the preparation of scientific and technical communications.

Board of Engineering Research

THE Board of Engineering Research was established in 1950 as an advisory body to the Council with the object of initiating and fostering research in various branches of engineering.

At the first meeting of the Board held in September 1950, the Board recommended that a survey of research facilities in existing institutions and of problems requiring study and investigation should be undertaken. The Board set up five expert committees, viz. Hydraulic Engineering Committee, Electrical & Power Engineering Committee, Mechanical Engineering Committee, Aeronautical Engineering Committee and the Civil Engineering Committee. The Electrical & Power Engineering Committee has constituted a Subcommittee on Wind Power.

At the instance of the Director, Scientific & Industrial Research, a detailed survey of research work carried out in India has been undertaken and completed. The results of the survey will be published shortly. The survey covers all branches of engineering and information has been collected from national laboratories engaged in engineering research, hydraulic research stations, and engineering research units attached to technical departments functioning under the Ministries of the Government of India. Problems requiring attention under an integrated programme of research have been indicated.

To stimulate research in engineering subjects, the Board has instituted four research fellowships.

The following research schemes have been sponsored by the Board.

1. Utilization of wind power for lift irrigation and generation of electric power — DR. P. NILAKANTAN, Pilani
2. Evolving an efficient design of bed sediment sampler — DR. H. L. UPPAL, Amritsar
3. Water purification plant — MR. D. V. JOGLEKAR, Poona
4. Housing for lower income groups — MRS. ELIZABETH S. GHUMAN, Delhi
5. Electric resistance strain gauges — DR. E. G. RAMACHANDRAN, Bangalore
6. Hardenability bands of low and medium steel alloys — PROF. P. K. DHAR, Kharagpur

VI

PATENTS, RESEARCH DEVELOPMENT & UTILIZATION

THE first patent of the Board of Scientific & Industrial Research was filed on 27 September 1940, within six months of the establishment of the Board. The laboratories of the Director of Scientific & Industrial Research were then located in the Government Test House at Calcutta. The invention related to a process for improving the mechanical and physical properties of relatively weak varieties of wood readily available in India. By the end of the following year, 15 patents were filed on the basis of work done in the laboratories of the Director. These inventions included processes for the manufacture of plastic compositions based on bhilawan and cashew-nut shell liquids, bagasse and jute wastes; use of vegetable oils as lubricants; manufacture of containers; and rubber compositions for the production of cork substitutes and insulating materials. A patent was also taken out for the degradation of readily available proteinous materials for the manufacture of air-foam solutions for fire fighting. New methods were evolved for preparing laminated flat and corrugated boards by the resin impregnation of fibrous materials such as jute, cotton, linseed fibre and paper.

Researches at the Delhi laboratories, during the years 1942 to 1946, yielded 50 patents. During the same period, 31 patents resulted from researches sponsored by the Board of Scientific & Industrial Research. A large number of inventions were concerned with new methods of processing bhilawan and cashew-nut shell liquids to obtain products suitable for use in lacquer varnishes, stoving enamels and waterproofing and electric-insulating compositions. Two patents were taken out for the expulsion of shell liquid from bhilawan and cashew nuts. Further researches led to the use of the shell liquids in the manufacture of such diverse products as moulding powders, patent leather and inks.

Further work on the degradation of proteinous and keratinous materials resulted in a number of patents, among which may be mentioned use of keratinous materials, such as horn and hoof wastes, for the manufacture of foam-generating substances and moulding powders.

Patents were taken out on new uses for castor oil products in the manufacture of waterproof and gas-proof fabrics, cold moulding compositions, pencil erasers and varnishes for insulating and like purposes.

Several inventions were concerned with the utilization of waste mica and patents were taken out on improved processes for grinding and pre-heating mica, and the use of waste mica in the manufacture of construction materials, such as slabs and boards, paints and plastic compositions.

Among other notable patents taken out during the period preceding the establishment of the national laboratories may be mentioned patents for improved methods of manufacturing phthalic anhydride; fluids for use in hydraulic mechanisms; compositions for detecting the presence of water in petrol tanks, kerosene and lubricating oils; methods for rendering textile fabrics non-inflammable and water-resistant; production of ammo-

minum carbonate and urea; compositions for lining and sealing containers; manufacture of sintered glassware; water-proof and grease-proof paper; flux compositions for aluminium and its alloys; extraction of rubber from secondary sources; and rubber lining of non-conducting surfaces.

A number of patents have resulted from work done to purify and derive new and useful substances of medicinal value from indigenous plant materials, such as *nim*, *Pristimera indica*, *karanja*, *polang* and *nagesaar*. Two patents were recently filed on the isolation of a new alkaloidal constituent (hayatin) from *Cissampelos pareira* and the manufacture of physiologically active substances from hayatin.

During the years 1946 to 1948, a number of patents were filed on new processes developed by research workers at Madras and Bombay for the synthesis of chemicals used in the field of dyestuffs and allied compounds. Patents for the manufacture of 2:4-dichloro-1-aminoanthraquinone and anthraquinone acid dyestuffs were taken out in the United Kingdom. Among other patents in this field may be mentioned those for the manufacture of benzidine, *p*-aminophenol, phenetoles, anisoles, nitroanisoles, nitrophenetoles, 2-nitro, 4-chlorophenetole, *o*-dichlorobenzidine, 3,6,3', 6'-tetrachlorobenzidine, 2,4-diaminophenol, 4-amino-*m*-cresol and dichloro-*o*-diphenetidine.

Researches in fermentation technology led to the patenting of a process for the production of distillery washes containing 10-14 per cent alcohol (by volume). This involved the fermenting of mash by a distinct strain of distillery yeast, the process for the production of which was covered by a patent. Among other biochemical processes patented may be mentioned manufacture of diastatically active mold compositions. A patent was also taken out for the recovery of useful byproducts in the manufacture of enzymes.

A method was developed in 1948 for the production of calcium gluconate by biological means. A patent was taken out for a new process for the manufacture of sorbose, which is the starting point for the technical synthesis of vitamin C.

National Laboratories

Chemical Research — Of the six patents filed by the National Chemical Laboratory in 1950, two were on the use of vegetable oils, such as tobacco seed oil, safflower oil and dehydrated castor oil, in the manufacture of paints, varnishes and lacquers. A patent was obtained for the production of modified alkyds using tobacco seed oil and another for the production of wrinkle finish coating compositions from modified alkyds. The utilization of *kamala* seed oil for obtaining kamlolenic acid and its derivatives and the use of *kamala* and the like oils for the production of wrinkle finish coating compositions have also been patented. Two patents have been taken out on the extraction of oil from oil-bearing material by means of water or steam. Various processes have been developed for the manufacture of cation exchange resins which have wide industrial use. Three patents employ *bhilwan* and cashew shell liquids in the manufacture of such resins. Among other patented inventions of the National Chemical Laboratory may be mentioned the preparation of photographic emulsions, manufacture of nicotine sulphate from tobacco wastes, a nicotine extraction tower, manufacture of high quality gelatin from indigenous sources of hides and skins, manufacture of saponins from Indian soapnut and

shikakai, transformation of castor oil gel into a viscous liquid for use in coating compositions, inks, etc., improvement of sugarcane wax by bleaching, a latex composition for can-sealing purposes, a new process for the modification of cashew-nut shell liquid for use in coating compositions and the manufacture of azo dyestuffs from cashew-nut shell liquid. New bactericidal and surface active quaternary ammonium compounds have been prepared by patented methods. Patents recently filed by the laboratory include the preparation of soft iodobromide positive emulsions from indigenous gelatin.

Physical Research — Of the seven patents which have been taken out by the National Physical Laboratory, two relate to air-conditioning and cooling apparatus and two to arrangements for cleaning producer gas. One patent relates to the solar cooker. Other inventions are a gas carburettor and a device for the detection of cracks in metals.

Food Technology — Thirteen patents have been filed on inventions for the solvent extraction of oil-bearing materials; manufacture of starch from banana; manufacture of milk, curds and like products from groundnuts; preparation of malted milk and concentrated protein food; treatment of fruit juices for making new and improved products such as fruit juice powders; manufacture of fructose from *agave* plant; a process for improving the storage life of cashew kernels; and an apparatus for the deodorization of foods and the recovery of volatile principles from food and other substances.

Leather Research — Patents have been filed on processes for improving myrobalan liquor used in the myrobing process of East Indian tannage of skins and kips; preparation of synthetic tanning material from *bhilawan* and cashew-nut shell liquids and other sources, production of improved tanned liquors from vegetable tanstuffs; and preparation of basic aluminium sulphate for use as tanning salt or in dyeing. Patents have recently been filed for the manufacture of picking band leather, upholstery leather, tanned reptile skins and enzymic dehairing of skins.

Fuel Research — A patent has been taken out for the manufacture of glucose by boiling starch or dextrin with a hydrogen ion-exchanger in the form of treated coal or synthetic resin. Other patents relate to the manufacture of ion exchangers from coal, peat, lignite and similar naturally occurring vegetable decomposition products; preparation of active carbons from coals and lignites; preparations based on the solvent extraction of coal; and utilization of low-grade coal in cement manufacture.

Glass & Ceramic Research — Patent applications were filed in 1946 for the construction of a novel glass working lathe for the manufacture of thermos flasks. Two patents have been taken out for the manufacture of foam glass. Bricks have been made from waste mica by a new method. Special enamels suitable for resistors have been patented. Patents have also been filed for the manufacture of boron-free enamels and pink enamels.

Metallurgical Research — The process developed by the National Metallurgical Laboratory for the recovery of beryllium oxide has been patented in India, U.K., France and U.S.A. Other patents include: cyanide-free bath for brass plating; process for the metallization of non-conductors; processes for the utilization of manganese ore; and electrolytic production of high purity manganese dioxide.

Building Research — A patent was taken out in 1950 for a process of soil stabilization. In the current year, three patents have been filed on the production of single twisted or twin twisted steel bars; construction

of floors, and improvements relating to the manufacture of pre-stressed concrete.

Sponsored Research

Out of the 30 patents arising out of researches financed by the Board of Scientific & Industrial Research during the last five years may be mentioned five patents relating to radio signals fading recorder, a high speed recorder for use with infra-red spectroscope, a microphotometer, a variance meter and an apparatus for the measurement of infra-red radiation during day time. Two patents were filed on new processes for the synthesis of insecticides, one known as "TEPP" and the other for the preparation of *o,o*-diethyl phosphoric acid ester of 4-methyl umbelliferone. Other patents from this source relate to the manufacture of chlorinated rubber, heat bodying and isomerization of linseed oil, saccharification of cellulosic material, recovery of sulphur from copper pyrites and the recovery of constituent metals from copper base scrap.

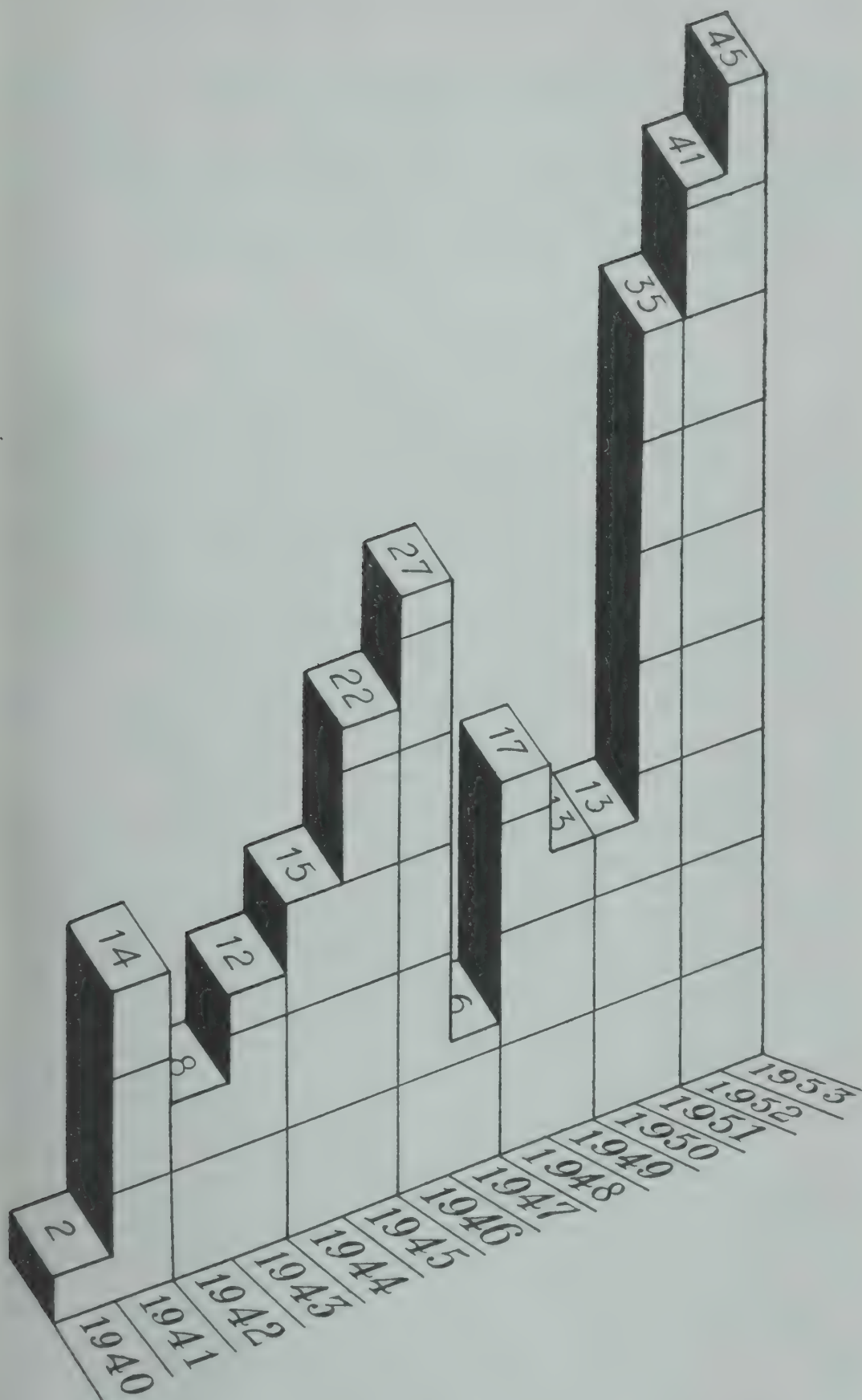
Table 1 gives the number of patent applications filed during the period 1940-1953. The Council has to its credit 270 inventions; of these 190

TABLE 1—PATENT APPLICATIONS FILED, 1940-53

YEAR					NUMBER
1940	...	...	...	...	2
1941	...	...	...	...	14
1942	...	...	...	...	8
1943	...	...	...	...	12
1944	...	...	...	...	15
1945	...	...	...	...	22
1946	...	...	...	...	27
1947	...	...	...	...	6
1948	...	...	...	...	17
1949	...	...	...	...	13
1950	...	...	...	...	13
1951	...	...	...	...	35
1952	...	...	...	...	41
1953	...	...	...	...	45
TOTAL					270

TABLE 2—PATENTS ACCORDING TO SUBJECTS

Chemical processes and products	...	...	127	(49%)
Drugs	...	...	27	(10%)
Food	...	...	12	(4%)
Leather	...	...	15	(6%)
Fuel	...	...	3	(1%)
Glass and ceramics	...	...	11	(4%)
Electro-chemical	...	...	15	(5%)
Metallurgical	...	...	14	(5%)
Mechanical and electrical devices	...	...	29	(12%)
Building	...	...	4	(2%)



PATENT APPLICATIONS FILED BY THE COUNCIL OF SCIENTIFIC & INDUSTRIAL
RESEARCH DURING 1940-1953.



(70 per cent) patents have been sealed; 17 (6 per cent) have been accepted; 50 (19 per cent) are pending; and 13 (5 per cent) have been abandoned.

An analysis of the research centres from which patentable inventions have originated shows that 193 (72 per cent) patents have come from the Council's laboratories and 77 (28 per cent) from sponsored research. Table 2 gives a classification of patents according to subjects.

A list of all the patent applications filed by the Council is given in Appendix III.

Research Development & Utilization

The question of translating results of research into commercial processes, which is of concern to both research and industry, has engaged the attention of the Council since its inception. The Industrial Research Utilization Committee was set up in 1941 for tendering advice on the "best method whereby industrial development of research can be undertaken and an equitable arrangement made for securing that the services of the scientists concerned are rewarded". This committee was replaced in 1947 by a more compact body, the Industrial Liaison Committee, with the same duties and functions. The work of this committee was transferred to the Ministry of Industry & Supply (now the Ministry of Commerce & Industry) in 1949 as it was felt that the Ministry was in a more advantageous position to follow up the progress of processes handed over to industry for utilization.

The procedure adopted by the Council in securing the commercial utilization of new processes is briefly as follows: When the progress of a particular investigation is reported to the Council to have reached the stage when its further development and commercial exploitation can be considered, a "non-technical" note on the subject is prepared for scrutiny by the Utilization Branch of the Council. Relevant technical details, finances required for capital and recurring expenditure, equipment, availability of raw materials, market prices and estimated costs of production are examined and the details considered by an *ad hoc* committee of experts, which includes the investigator or investigators concerned. The non-technical note as approved by the committee is printed and circulated to chambers of commerce, other commercial bodies and industrial concerns, and those desirous of taking up the process for exploitation are invited to state their terms. Non-technical notes are also published in the *Journal of Scientific & Industrial Research* and press notes are issued to ensure wide publicity.

The offers received are considered jointly by the Council and the Ministry of Commerce & Industry in the light of the procedure formulated by the Council and a decision is taken for the utilization of the process.

Processes which do not involve substantial capital investment, those which can be worked in industrial concerns without additions to or modification of existing plant and machinery, those which can be adopted on a cottage industry basis, and those which are of public benefit are released for utilization unconditionally. In the case of other processes, the considerations which govern the selection of a concern (or concerns) for developing them are financial resources of the concern (or concerns), technical skill available, advantages with respect to raw materials, power, labour and transport facilities and financial terms. Facilities for future

research which the concern (or concerns) is prepared to offer are also taken into consideration. The Council offers all facilities and technical assistance including, if needed, the services of a technical expert to ensure the development of the process to the stage of commercial production.

The Council has so far leased out 55 processes for commercial exploitation (APPENDIX IV) and received nearly Rs. 2.54 lakhs in the form of royalties and premia. During the war period, a number of processes were handed over to the Supply Development Committee (Supply Department), R.A.F. and U.S.A.A.F. free of cost (APPENDIX IV). The benefits derived from these processes cannot be evaluated in terms of money but are known to be large and form valuable contributions made by the Council to the war effort. Besides, a few processes have been passed on to the States and some have been released to the public free of cost.

It is difficult to assess the financial benefits accruing to the country from the Council's work. Benefits derived from improvements in existing processes, for instance, are difficult to evaluate. Among the indirect benefits may be mentioned the increased earnings in income tax, super tax, excess profits tax and corporation tax, besides provincial and local taxes, which accrue to the Central Government as a result of the profits derived by industry from the Council's processes. To these might be added the benefits derived by the country's economy from savings in exchange resulting from diminution of imports of products developed from the processes.

To cite a few instances, anti-gas cloth valued at over one crore of rupees was manufactured from the Council's formula. The Council did not derive any direct monetary benefit but the indirect benefit to the country's economy is undoubtedly considerable. It is estimated that vegetable oil lubricants valued at Rs. 5 crores were produced by the oil companies from the processes worked out by the Council. The Council did not derive any direct monetary benefit from these processes, but if the oil companies made 10 per cent net profit, they would have paid taxes on Rs. 50 lakhs. In addition, some 50,000 tons of shipping space with sea freight and handling charges were saved. It may be mentioned here that Burmah-Shell and Assam Oil Companies have, partly in recognition of the Council's work on the utilization of vegetable oils as lubricants, instituted scholarships in Commonwealth countries to the value of Rs. 2,00,000 per year.

National Research Development Corporation

The work of the Industrial Research Utilization Committee and its successor, the Industrial Liaison Committee, has been of a pioneering nature. It emphasized the importance of research utilization and helped to bring inventors and industrialists together. It also stressed the need for devising operative measures for ensuring a better utilization of results of research.

The development of research to the stage of commercial production is a subject to which considerable thought is being devoted in industrially advanced countries. Specialist organizations have been set up in U.K., U.S.A. and Canada to bridge the gap between research and utilization, and to establish close liaison between laboratory and industry.

The Reviewing Committee of the Council (1949), presided over by Sir Ardeslar Dalal, gave considerable attention to the utilization aspect

of researches carried out under the Council's auspices. The committee recommended the setting up of a National Research Development Corporation of India for ensuring the effective utilization and exploitation of the results of research. This recommendation was accepted by the Council and a Special Committee was appointed to work out the details. The proposal submitted to the Government early in 1951 was endorsed by the Planning Commission in the First Five-Year Plan. The Government accepted the proposal in principle on 15 April 1953 and decided that funds for the Corporation should be provided in the form of a long-term loan free of interest or carrying a low rate of interest. It was also decided that the Corporation be constituted as a State-owned private company under the provisions of the *Indian Companies Act* and a committee was appointed to undertake all preliminary work for the establishment of the Corporation. The Corporation was registered on 2 December 1953.

The main objects of the Corporation, as laid down in its Memorandum of the Association, are:

1. To develop and exploit in the public interest for profit or otherwise:
 - (a) investigations, whether patentable or otherwise, of the Council of Scientific & Industrial Research, including technical and engineering know-how of processes;
 - (b) patents and inventions of different departments of the Government of India and State Governments, commodity research committees, and other statutory research organizations, including technical and engineering know-how of processes;
 - (c) such other patents as may be voluntarily assigned, by general or special agreement, by universities, research institutions or individuals; and
 - (d) such other processes and patents, the development of which may be entrusted to the Corporation by the Government of India;
2. to enter into reciprocal arrangements with similar organizations in other countries to exploit Indian inventions in those countries and their inventions in India;
3. to issue exclusive and/or non-exclusive licences on such terms and conditions regarding payment of premia, royalties, share of profits or any other basis as are considered advisable to commercially develop the invention and ensure commercial production of the products of inventions;
4. to secure co-operation of such State-owned or State-controlled industries or any units thereof as are deemed or are likely to be interested or necessary to develop the new processes or inventions and reimburse such industries any loss that they may incur;
5. to enter into agreement with a private firm or firms to develop inventions by trials at their works and to reimburse them any loss that may be incurred during these trials;
6. to install and work pilot, prototype or semi-scale units or full commercial plants to develop a particular invention or inventions and ensure production from such invention or inventions, to sell or otherwise dispose of the products of such inventions on payment or otherwise and generally on such terms and conditions as may be deemed fit;
7. to transfer by sale, lease, hire or otherwise dispose of any pilot plant, prototype plant, semi-scale plant or fully commercial plant

- to any firm, individual, association or institute and entrust the same with commercial production of any products of invention or inventions for which the plant or plants had been installed on such terms and conditions as may be deemed fit;
8. to afford facilities for advising and assisting Government departments, universities, research institutions and individuals in making applications for patents and prosecuting the same before the Controller of Patents and to frame rules for the purpose and to vary them from time to time;
 9. to distribute a share of profits, premia and/or royalties from any particular invention or inventions to Government departments, institutions, organizations, universities, or individuals from whom such invention or inventions were received and to frame rules for the purpose and vary them from time to time;
 10. to reward, in special circumstances, any particular invention or inventions by gifts, rewards, ex-gratia payments or in such other manner as may be deemed fit.

VII

PUBLICATIONS

“THE collection and dissemination of scientific information in regard not only to research but also to industrial matters generally and the publication of scientific papers and a journal of industrial research and development” are among the functions of the Council of Scientific & Industrial Research. To fulfil this function the Council established, in July 1942, two small units, the Office of the Dictionary of Economic Products of India and the Journal of Scientific & Industrial Research. Since that date, the publication activity of the Council has gradually increased. With the rapid expansion of the Council, the necessity for co-ordinating the publications was keenly felt and the Governing Body created in 1951 the Publications Division to handle all the work connected with the publications of the Council.

The technical work of the Division is under the charge of the Chief Editor. The Division is divided into 5 sections: Raw Materials, Industrial Products, Journal of Scientific & Industrial Research, Other Publications, and Documentation. The work relating to the first four sections is looked after by assistant editors. There are two assistant editors, one for cultivated crops and the other for medicinal and forest plants in the Raw Materials section. The Documentation Officer looks after the work of the reference library and documentation. The routine administration of the Division, the work of *CSIR News* publicity and sales of publications are handled by the Assistant Secretary (Publications). There are two junior technical officers connected with publications, and one of them is in charge of the *National Register of Scientific & Technical Personnel*.

The publications brought out by the Division may be classified as follows:

- (1) Wealth of India — A Dictionary of Indian Raw Materials and Industrial Products
- (2) Periodicals — Journal of Scientific & Industrial Research, Vigyan Pragati and CSIR News
- (3) Bulletins and Monographs
- (4) National Register
- (5) Miscellaneous

A detailed account of the publications is given below.

Wealth of India

One of the most important publications of the Council is the *Dictionary of Indian Raw Materials & Industrial Products* — an encyclopaedia under the general title *Wealth of India*. Soon after the Council was established, it was felt that there was one field, viz. the natural resources of the country, in which collection and dissemination of infor-

mation was necessary in the interests of the economic development of India. It is of interest to describe in this connection the pioneering work of George Watt who, as Reporter on Economic Products with the then Government of India, compiled and published towards the close of the last century the *Dictionary of Economic Products*, a monumental contribution on the raw material resources of India. Watt's attempt was to provide "an approximately complete résumé of the opinions of Indian authors and the results of extensive official and private enquiries regarding the economic products of India", the aim being "to bring the trade and capital of the west into more direct contact with the resources of the Indian Empire and to provide a guide to the industrial *entrepreneur*, the administrator and the student of economics". A critical appraisal of the information was not attempted and Watt himself suggested that a revision of his work would be necessary to remedy some of the "defects" in his compilation.

The period since the publication of Watt's work has been one of rapid changes in India. From a predominantly agricultural country, India has emerged as a semi-industrialized state. Scientific research has led to the acquisition of new knowledge on material resources. The appetite for knowledge has quickened and the demand for properly documented and critically appraised information has become keen and widespread. A compendium of information and data on the present and potential wealth of India is called for.

Taking all these facts into consideration, the Governing Body of the Council of Scientific & Industrial Research accepted, in April 1942, the recommendation of the subcommittee of the Board for the compilation of a Dictionary of Raw Materials of India on lines similar to those of Watt's *Dictionary of Economic Products*. An Advisory Board was appointed on 8 December 1942 and a small Editorial Committee was constituted, which issued detailed instructions to the staff and directed that the resources of India as well as those of Burma and Ceylon should be surveyed. The Editorial Committee appointed subcommittees of experts for assisting the work of the following sections of the dictionary: (1) cultivated and medicinal plants; (2) forest flora; (3) animal products; (4) minerals; (5) chemicals; (6) industries and industrial resources; and (7) economics and statistics.

In the early stages of this work, it was proposed to invite specialists to contribute the major articles for the dictionary and to compile articles on minor subjects in the office. In consultation with the various subcommittees, lists of the more important items to be included in the dictionary were prepared and a large number of invitations for contributions were sent to various institutions and specialists. It was proposed to publish the contributions received in current journals and to make use of the suggestions received to finalize the drafts. The response to the requests sent out, however, was discouraging, and it became necessary to revise the procedure and to start the work of compilation from the beginning.

The ledgers which had been compiled by Watt and his assistants in his time had been distributed to various institutions. Some of these ledgers were not traceable; others had not been kept up to date. The result was a *de novo* effort to collect, classify and assess all the information on every subject. The work of compilation was started in 1944.

This encyclopaedia, aptly named *Wealth of India*, is likely to run into ten volumes, each volume being divided into two sections, one dealing with raw materials and the other with industrial products. About

INDIA



SUGARCANE	↑	ILMENITE, MONAZITE & ZIRCON	IMZ
JUTE	J	CHROMITE	C
RUBBER	⊖	CATTLE	🐄
COFFEE	✂	SHEEP	🐑
TEA	Σ	WOOL	W
OILSEEDS	🌱	HIDES & SKINS	🐖
TOBACCO	🌿	LAC	🐛
COAL	⬤	SILK	🐛
MICA	□	AIRCRAFT	✈
PETROL	⬜	TEXTILES	🧵
CEMENT	🏠	HYDRO-ELECTRIC PROJECTS	⚡
STEEL	⌘	SHIP BUILDING	🚢

RAILWAYS



MEMORANDUM

DATE: 10/10/50

10/10/50

4,000 topics will be dealt with in the alphabetical order. Of these 90 per cent relate to plant materials and the rest to animal products, mineral resources and industries.

The information for the articles is collected and collated from standard works, scientific periodicals, and publications of Government departments and research institutions. The latest available information on the uses, potentialities and economic data of production, imports and exports are given. Sources of information are indicated and in compiling articles an attempt is made to critically evaluate the source materials. References are given to facilitate the interested reader to pursue further inquiry into any topic.

So far six volumes, three dealing with raw materials and three dealing with industrial products, have been published. The compilation of material for the next two volumes has been nearly completed.

In his general introduction to the encyclopaedia, the Prime Minister observed: "I have no doubt that this book, produced by many scholars and experts and after much labour, will be of great value to the builders of new India. It should be of value also in educating the average citizen, who should take interest in this fascinating land and its enormous potentialities."

The volumes published so far have been warmly received in scientific circles both in India and abroad. The reviews in the leading scientific periodicals of the world commended the plan of the work and the manner in which the work has been carried out. A few excerpts from the reviews are given below:

"The field which has been covered is remarkably wide. A high standard is maintained throughout, and the articles contain adequate literature references . . . We look forward with pleasure to the appearance of further volumes, which will be indispensable to all who are interested in natural products" — *Nature*, **163** (1949), 743.

"One cannot but be impressed by their (of the articles) high quality, their value being much increased by the numerous references to the original literature. In dealing with agricultural products, not only are details given of the most satisfactory methods for their cultivation, their processing and their chemistry, but also statistics are included of Indian production and exports" — *Nature*, **168** (1951), 618.

"The great majority of the articles are models of concise and authoritative statement. References to original literature have been abundantly provided and there is a welcome absence of excessive detail.

"The standard of production is also commendably high. The two parts of Vol. I represent a notable achievement, and if the succeeding volumes maintain this level, the work should achieve the objects of those responsible for its conception, namely, to provide a standard work of reference on the economic resources of India" — *Science Progress*, **38** (1950), 196.

"This monumental work, assembled by a number of Indian scholars, supersedes and immeasurably improves upon the classic works of George Watt" — *Economic Botany*, **4** (1950), 94.

"A monumental achievement — unique in regard to the wealth of information it contains" — *World Crops*, **3** (1951), 181.

"A mine of exact information of great value to the world's planners and to others whose interests are less urgent" — *Tropical Agriculture*, **28** (1951), 34.

"Excellent for reference general reading and teaching — should be in all libraries, universities and other scientific institutions" — *Science*, 114 (1951), 49.

Periodicals

JOURNAL OF SCIENTIFIC & INDUSTRIAL RESEARCH

Two monthly periodicals, one in English — the *Journal of Scientific & Industrial Research*, and the other in Hindi, *Vigyan Pragati*, are published by the Council. The former, which has been recognized as the foremost scientific journal of the country, was started as a quarterly in 1942 to serve "as the link between the scientist and his laboratory on the one hand, and the wider interested public on the other" and "to place before the scientists and the lay public the results of various researches carried out from time to time and so to stimulate both scientists and industrialists to further efforts in research on the one hand, and the utilization of such research on the other". An Editorial Board consisting of Dr. Shanti Swarup Bhatnagar (*ex officio* Chairman), Dr. J. C. Ghosh, Dr. Jivraj N. Mehta, Dr. S. Krishna, Dr. K. S. Krishnan, Dr. Nazir Ahmad, Dr. Mata Prasad, Dr. B. L. Manjunath, Dr. M. Qureshi, Shri T. S. Pillay, Prof. M. N. Saha and Shri B. N. Sastri (Editor and *ex officio* Secretary) was appointed. In considering the scope of the *Journal*, the Editorial Board took into account the emphasis which industrial research had received in India, especially since 1940 when the Board of Scientific & Industrial Research was inaugurated, and the need for a periodical to publish the results of researches carried out under the Council's auspices in its own laboratories and in the universities and research institutions under the grants-in-aid schemes. These requirements were met by a broad-based publication programme and the *Journal* was to include original research papers, technical articles on raw materials and semi-manufactured products, review articles on recent developments in different branches of applied research, abstracts of research papers, non-technical notes, reviews of scientific and technical publications, and notes on patent literature. The Editorial Board sought and secured the co-operation of a large number of distinguished scientists to assess the merits of papers received for publication and generally to assist the progress of the *Journal*.

The first number of the *Journal* appeared in October 1942 and was welcomed warmly by scientists and industrialists in India and abroad. Reviews appearing in scientific periodicals made it abundantly clear that the *Journal* supplied a real need. Under the guidance of Dr. S. S. Bhatnagar, the *Journal* made rapid progress and the Editorial Board was soon called upon to increase the frequency of publication to ensure prompt publication of technical papers emanating from the rapidly expanding activities of the Council of Scientific & Industrial Research.

From a Quarterly to a Monthly — At the meeting of the Editorial Board held at Bangalore in November 1943, it was decided to issue the *Journal* as a monthly publication. The first monthly number appeared in July 1944. Provision was made to increase the size of each number to 64 pages, exclusive of advertisements. The strength of the Editorial Board was augmented and Dr. C. V. Raman, Dr. H. J. Bhaddra and Dr. D. N. Wadia were invited to join the Board.

The need for a separate section containing original research communications having been felt, it was decided in 1946 to publish the *Journal* in two sections — A and B — each section having a separate contents page and serial pagination; the two sections were to be provided with separate title pages and author and title indexes. The first number in two sections appeared in July 1946.

The in flow of contributions to the *Journal* has been steadily increasing, and it has become increasingly difficult to publish accepted papers within the size limits set for the *Journal*. The position was reviewed by the Editorial Board at the meeting held in November 1951. It was decided to increase the number of pages in each issue to 100 as an immediate measure for ensuring prompt publication of research communications. The Editorial Board also directed the Editor to invite prominent scientists in India and abroad to contribute review articles on their specialized fields. These recommendations are being given effect to. It has since become necessary to increase the number of pages to 120 in each issue.

Contents & Format — During the period 1942-45, scientific effort was largely directed to the finding of alternative and substitute materials for the production of articles which, on account of World War II, were in short supply. This was reflected in the *Journal* and many articles on raw materials for industry and their utilization were published. Current developments in industry and post-war planning for scientific research were discussed in many papers appearing during this period.

After the cessation of hostilities, many of the plans for expanding research activities in India, initiated largely by the CSIR, were given effect to. The emphasis was no longer on problems of short-range interest. National laboratories were established in various parts of the country and investigations on problems basic to the development of industries were undertaken. With the rise in the tempo of research, there was a progressive increase in the number of original papers communicated for publication in the *Journal*. This is reflected in the *Journal* by the increased space devoted to original research papers.

Developments in scientific and industrial research are watched and specialists are invited to review them in the *Journal*. The assistance and co-operation of the Council's Research Committees in this work have proved invaluable. Research workers are requested, from time to time, to contribute reviews of their work for publication.

The *Journal* office receives, on an exchange basis, nearly 250 scientific periodicals and technical reports from all parts of the world. Selected articles from these publications and from others obtained through subscription in the Publications Division are abstracted and published in the *Journal*. In addition, annual reports of learned societies and research institutions in India and abroad are collected and the information contained in them is summarized for publication in the *Journal*.

A classified list of titles of research papers appearing in Indian scientific periodicals and notes on scientific apparatus and equipment are published in every number of the *Journal*.

With the formation of the Publications Division of the Council in 1951, adequate library facilities have become available to the *Journal*. The resources of the Documentation Section, built up primarily for aiding the compilation of the *Dictionary of Indian Raw Materials & Industrial Products*, have proved particularly valuable for the work of the *Journal*.

Contributions received for publication in the *Journal* are handled according to a procedure laid down by the Editorial Board and every effort is made to publish them expeditiously. The co-operation of authors is solicited for obviating delays which inevitably occur when manuscripts, inadequately prepared, are submitted for publication. A committee, consisting of representatives of the Council and of the National Institute of Sciences of India, set up at the instance of Dr. S. S. Bhatnagar, has examined the question of preparing "Scientific and Technical Papers" and has formulated guiding principles for adoption by authors.

The *Journal* has adopted the standard layout specified by the Indian Standards Institution (ISI). The Editor of the *Journal*, as the Council's nominee on the ISI Documentation Committee and of its several sub-committees, has participated in the preparation of standards for indexing, abbreviations, etc. These standards have been adopted in the *Journal*. Every effort is made to improve the presentation of material received for publication. Contacts are maintained with abstracting and publicity organizations so that the information appearing in the *Journal* is conveyed quickly to those interested. The press releases from the Council's Publications Division also assist in the prompt dissemination of news relating to the contents of the *Journal*.

The regularity in the publication and attention given to the get-up have contributed to the rising popularity of the *Journal* and contributions from many research centres in the country are received for consideration. A numerical classification of articles published in the *Journal*, according to sources, is presented in Table 1.

TABLE 1 — ARTICLES PUBLISHED IN THE JOURNAL, 1942-53

Classification according to sources

STATE	NUMBER
Bengal	274
Bihar	114
Bombay	172
Delhi	333
Hyderabad	28
Jammu & Kashmir	9
Madhya Pradesh	7
Madras	213
Mysore	124
Punjab	6
Rajasthan	1
Saurashtra	7
Travancore-Cochin	24
Uttar Pradesh	119

Wide Recognition — The *Journal* reaches almost every country in the world. This has been rendered possible through the good offices of the Indian Embassies and Trade Commissioners in different countries. Press releases relating to the contents of the *Journal* are also distributed through these agencies.

The *Journal* has received wide recognition as a reference periodical. Requests are frequently received from editors of scientific periodicals for permission to reproduce articles appearing in the *Journal*. Requests for supply of the *Journal* on exchange basis are received from many countries. Review copies of books from several publishers, e.g. McGraw-Hill, Chapman & Hall, Elsevier, Interscience, and Cleaver Hume, are regularly received for notice.

VIGYAN PRAGATI

This is a monthly bulletin in Hindi devoted to the dissemination of research information for small-scale and cottage industries. It was started in August 1952. The bulletin contains information on the following.

1. Developments regarding small-scale and cottage industries in various States. The information given under this Section relates to new industries established, progress of existing industries and technical improvements in equipment and processes which contribute to production efficiency.

2. Results of researches carried out in the national laboratories of the CSIR, particularly those of interest to subsidiary and small-scale industries.

3. Information relating to patents which are of interest to subsidiary and small-scale industries.

Vigyan Pragati is entering on its third volume in January 1954 and is proving increasingly popular. Requests for exchange of *Vigyan Pragati* with other journals and exchange of advertisements are frequently received. Each issue consists of 28 pages of text matter, containing the following sections: (1) review articles; (2) research institutions; (3) reviews of scientific and technical publications; (4) notes and news; (5) enquiries; and (6) patents.

The dissemination of research information to assist small-scale industries in the language which the artisan understands is a gigantic task. The manner in which this objective can be effectively achieved has to be evolved by a process of experimentation. The Council has under consideration the development of rural science centres and an experimental "Vigyan Mandir" has been recently established in a village in the suburb of New Delhi. It is hoped that the attempt "to take science to the villages" will be helped by *Vigyan Pragati* and the scope for its service will expand in the coming years.

CSIR NEWS

A fortnightly newsletter giving information on the activities of the laboratories and research committees is published on the first and third Saturdays of every month.

As the activities of the Council of Scientific & Industrial Research have expanded and its institutions are spread all over the country, from Roorkee in U.P. to Karaikudi in Madras and from Poona in Bombay to Dibrugarh in Assam, it was felt that it would be useful to have a fortnightly bulletin carrying news relating to the activities of the various institutions functioning under the Council. The national laboratories and research institutions and university laboratories in which the Council's

research schemes are investigated, are active centres of discovery and invention. The activities and achievements of the research organizations and of the many expert and advisory committees of the Council cover a wide field and are of concern to individuals and institutions engaged in the advancement of science and technology as a whole.

CSIR News was started in October 1951 and has proved extremely popular. It is distributed free to all those connected with the Council. The information is arranged under the following heads: (1) meetings and symposia, containing announcements of meetings; (2) personal, containing news about appointments, transfers, honours conferred on persons, etc.; (3) research committees, containing information on research schemes, surveys, etc., considered and recommended by research committees; (4) national laboratories; (5) CSIR patents, sealed, accepted and applied for and on behalf of the Council; (6) briefs, containing miscellaneous items of news; and (7) advertisements of the Council.

ANNUAL TECHNICAL REPORTS

Information for the annual reports is collected from laboratories and research committees and published by the Division.

Bulletins & Monographs

Publications relating to the activities of research committees are handled by the Division. The following publications have been brought out since 1951:

1. Distribution of British Pharmacopoeial Drug Plants and Their Substitutes Growing in India
2. Austenitic Grain-size Control of Steel
3. Investigations on the Composition and Nutritive Value of Vanaspati
4. Directory of Micro-organisms and List of Species Maintained in India
5. The Indian Pharmaceutical Codex
6. Low Cost Houses
- 7 & 8. Literature Review on Fats and Oils, 1949 and 1950
9. Research and Building Construction in India
10. Concrete Shell Construction

The Division has on hand the following publications:

1. Symposium on Problems Relating to Internal Combustion Engines Industry in India
2. Survey of Problems Relating to Plastics
3. Rose Cultivation and Rose Attar Oil Industry
4. Jasmine
5. Cottonseed and Its Products
6. Adapted Processes for the Manufacture of Boxside
7. Adapted Processes for the Manufacture of Glazed Kids
- 8 & 9. Literature Review on Fats and Oils, 1951 and 1952

Revision of some of the publications issued by the Industrial Research Bureau, prior to the creation of the Council of Scientific & Industrial Research, has been undertaken at the suggestion of the directors of national laboratories or Research Committees. The following bulletins have been published.

1. Manufacture and Application of Liquid Gold
2. Utilization of Indian Vegetable Oils as Lubricants in Internal Combustion Engines
3. Indian Vegetable Oils as Fuels for Diesel Engines

The Division has been asked to bring out a new edition of *Indian Vegetable Oils* by Brodie and Sen Gupta, and *China Glass* by Dr. Atma Ram and Dr. Lal C. Verman. The revision work has been taken up.

The National Register of Scientific & Technical Personnel

Another important publication of national importance produced by the Council is the *National Register of Scientific & Technical Personnel*. The Scientific Manpower Committee set up by the Government of India, under the chairmanship of Dr. S. S. Bhatnagar, recommended to the Government "the maintenance of a register of scientific and technical personnel to facilitate their utilization to the best advantage". The Government of India accepted the recommendation and the work of compiling the register was entrusted to the Council of Scientific & Industrial Research. The Council of Scientific & Industrial Research was also asked to take steps to establish an employment bureau under it to place the scientific and technical manpower available in suitable jobs.

A suitable questionnaire was sent round and all scientists and men with technical qualifications were requested to give relevant details about themselves. With the data thus collected, the Register is being compiled in three volumes:

- Volume I — Engineers (civil, electrical, mechanical, electrical and mechanical, chemical, marine, mining, aeronautical, automobile and communication)
- Volume II — Medical Personnel (medical graduates, medical licentiates and dentists)
- Volume III — Scientists and Technologists (working in scientific fields, such as mathematics and statistics, physics, meteorology, chemistry, geology and mineralogy, metallurgy, anthropology, botany, zoology and entomology, agriculture and horticulture, plant breeding and genetics, plant pathology, animal husbandry and dairying, veterinary science and forestry)

The compilation of the Register was commenced in 1949. So far the following volumes have been published:

- Volume I — Engineers — 3 parts (11,916 entries) — completed
- Volume II — Medical Personnel — 2 parts (8,800 entries)
- Volume III — Scientists and Technologists — 2 parts (9,291 entries)

At present Part III of Vol. II — Medical Personnel is being compiled. The entire work is expected to be completed by the end of 1954.

Miscellaneous

Apart from the publications mentioned above, there are a few other unclassified publications, e.g. *Patented Inventions of the CSIR* and *Index to Duthie's Flora*, brought out by the Division. The publication of A Glossary of Indian Medicinal Plants by Col. R. N. Chopra is now on hand.

PUBLICITY & SALES

The question of publicity and sales was fairly simple until 1951, when the Publications Division of the Council was created by the amalgamation of the Journal Section and the Dictionary Office. The Division had to direct attention to the stocking of publications and to the organization of sales.

The following steps are taken to publicize the publications:

1. A press note is issued at the instance of the Council by the Press Information Bureau and published in leading newspapers and journals.
2. A note prepared in the office is circulated among agents, book-sellers and institutions likely to be interested in the publications.
3. In the case of publications like the *Wealth of India*, special folders are printed and distributed.
4. Circulars are sent to the External Publicity Division of the External Affairs Ministry and publicity is arranged through the Indian Embassies in foreign countries. The *Wealth of India* is stocked in the Indian Embassy in Washington and in the High Commissioner's Office in London.
5. Occasionally, advertisements regarding publications are inserted in scientific journals in India and abroad and in Indian newspapers. The *Journal of Scientific & Industrial Research* is advertised on a reciprocal basis in *Current Science*, *Journal of Zoological Society*, *Journal of the Indian Institute of Science* and *Impact*.

The following procedure is adopted for securing new subscriptions and advertisements for the *Journal of Scientific & Industrial Research*:

1. Circular letters inviting prospective subscribers (research and technological institutions, colleges, industrial establishments and individual scientists and technologists) to enlist themselves as subscribers to the *Journal* are issued from time to time. On an average, 2,000 circulars are sent out each year.

2. Circulars are also issued from time to time to prospective advertisers.

At present, 40 booksellers have been appointed as agents in various cities for selling the publications of the Council.

The proper storage of books and periodicals is also the responsibility of the Division. Stored books are frequently dusted and suitable protective measures are taken against insect attack.

GENERAL

The description given above of the various publications handled by the Division does not give any indication of the organization which has been built up to bring out these publications.

Compilation of existing information on the subject covered by the publication is a primary requirement. Scientific information is scattered in pamphlets, reports, proceedings and transactions of learned societies, and in bulletins, memoirs and scientific periodicals published in India and abroad. The Division deals with publications relating to almost all the sciences and a good reference library is a *sine qua non* of its activities. Such a library has been organized by pooling together the resources of the Dictionary office and the Journal section.

Library — The library has a stock of 6,157 publications comprising books, periodicals, reports and pamphlets. Of this total, books account for 1,809 volumes and journals 1,234 volumes, the rest being reports and pamphlets. The library receives 441 periodicals of which 50 are purchased. More than 250 journals are received on exchange for the *Journal of Scientific & Industrial Research*. Sixty-two journals are sent to the NPL-Insdoc for deposit. The library has been recognized as a depository library by the United Nations Food & Agricultural Organization for their publications. The United States Government have made a gift of 926 books to the Council of which 132 have been retained in the library and the rest sent to Insdoc for retention and distribution to various institutions in India. The United States Department of Agriculture has also recently donated 147 publications to the library.

Documentation — The journals, periodicals and other publications received in the library are scanned and indexed in the Documentation Section. At present there are 62,257 cards, classified and arranged according to subjects, and every month nearly 1,100 cards are added. A number of ledgers on particular subjects, containing information extracted from books, journals, reports, etc., is maintained by the Section.

The information collected in the card index and in the ledgers has often to be supplemented by consulting individual scientists and corresponding with specialists and Government departments. Resources of other libraries have to be tapped to collect all the information required for compiling the materials required for the publications issued by the Council.

The sifting of information thus collected and the working of the sifted material into a finished piece is the job of the editorial staff. The work of the editorial wing is supplemented by that of the production wing which takes charge of the manuscript, prepares illustrations — photographs and pen-and-ink drawings — and determines the layout. A dark room, suitably equipped for photocopying and enlarging, has been fitted up. Graphs, charts and coloured drawings and pen-and-ink illustrations are prepared by artists in close liaison with the editors. A large number of colour plates relating to plants have been acquired or are prepared for illustrating the publications.

The work of the Division does not cease with the handing over of manuscripts to the press. Apart from proof-reading — and here it may be pointed out that the proof-reading of technical publications can be done best by technical men and not by the usual proof-readers — the question of arrangement of matter, size and position of text illustrations, and plates, size of the book, style of binding, etc. — all these are settled by the Division.

Enquiries — The Publications Division is engaged in some activities which are in a way the offshoots or byproducts of the main work. Thus the Dictionary Section of the Division acts as a Technical Information Bureau for the raw materials of India. The ledgers opened for the compilation of the Dictionary are a storehouse of information of Indian raw

materials and industrial products. Numerous enquiries are received and these relate to all aspects of Indian raw materials ranging from their local and vernacular names to their distribution, methods of cultivation, acreage, yield and export and import. All such enquiries are properly and fully answered. The Journal Section also handles a large number of enquiries from subscribers and readers and this activity has substantially increased during recent years. Most of these requests are for detailed information on specific topics. The enquiries are attended to promptly and, as far as possible, complete information is supplied. In some cases the enquirer is directed to sources from which fuller information can be obtained.

Printing — The Council has no press of its own and has to rely on Government or private presses for printing its publications. The *Journal of Scientific & Industrial Research* is printed at present in the Catholic Press, Ranchi, and several publications are printed in other private presses.

VIII

INDIAN NATIONAL SCIENTIFIC DOCUMENTATION CENTRE

THE project for the establishment of a national centre to provide documentation services to the national laboratories, scientific institutions, universities and industrial concerns, which had been under consideration for some years, took concrete shape when the Government of India entered into an agreement with Unesco on 7 July 1951, under which Unesco would provide technical assistance over a three-year period for the organization of the centre. The assistance to be provided comprised:

1. The services of 3 expert advisers;
2. grants for books and periodicals;
3. grant for equipment; and
4. study grants and scholarships

The Government of India undertook to provide the following recurring expenditure for the centre:

1. Rs. 10,000 for local currency expenditure in 1951-52
2. Rs. 1.5 lakhs in 1952-53
3. Rs. 2 lakhs in 1953-54

The Indian National Scientific Documentation Centre (Insdoc) was established in 1952 with the following functions:

1. to receive and retain all scientific periodicals required in India, particularly those required by the universities, scientific research organizations and government laboratories;
2. to supply photo-copies and translations of articles required by laboratories or individual workers;
3. to meet demands for abstracts as far as possible;
4. to prepare an index of the journals available and the journals required for various subjects;
5. to answer enquiries from information available in the Centre;
6. to be a national repository for reports of the scientific work of the nation, both published and unpublished; and
7. to be a channel through which the scientific work of India and the surrounding countries is made known and made available to the rest of the world.

Organization

The organization of the Centre was entrusted by the Government to the Council of Scientific & Industrial Research. The Centre is under the administrative control of the Director, National Physical Laboratory, New Delhi, and is located in the buildings of the laboratory. The

responsibility of organizing the Centre and the technical administration of the services is that of the Head of Insdoc. An Advisory Committee with the Director, Scientific & Industrial Research, as Chairman, and the Head, Insdoc, as Secretary, has been constituted by the Government for giving advice on all matters concerning the Centre. The Advisory Committee has appointed a Technical Subcommittee to advise on technical matters.

There are at present three sections in Insdoc, viz. the Abstracting and Documentation Section, the Translation Section and the Photographic Reproduction Section. Three experts, deputed by Unesco according to the agreement, have joined the Centre to help the three sections. They are Mr. J. B. Reid, Adviser on Documentation and Head of the Technical Assistance Team, Mr. A. L. Gardner, Adviser on Translations and Mr. A. A. Pelletier, Adviser on Reproduction of Documents.

Abstracting & Documentation Section — The work of this section is to trace and locate scientific references, compile bibliographies on special subjects, classify and abstract scientific articles, collect and index scientific reports published in India and supply information to other organizations.

The staff in this section consists of two senior documentation officers, one junior documentation officer, one senior technical assistant and one junior librarian.

Translation Section — This section arranges to translate scientific and technical papers into English from other principal languages. Abstracts of scientific papers published in languages other than English are also prepared on request. A Panel of Translators has also been set up and names of suitable linguists and scientists who know languages other than English are enrolled on it. Part time work is allocated to panel members keeping in view their specialized qualifications and knowledge of languages. The translations completed by the panel members are edited by the section before issue.

The staff in this section consists of two senior translating officers and two junior translating officers.

Photographic Reproduction Section — This section prepares microfilm copies or photo-copies of scientific articles required by various scientists and scientific institutions. This section will shortly take in hand preparation of photo-offset plates for printing of the proposed publication of the Centre.

The staff in this section consists of two junior photographic officers; one photographic assistant; and two laboratory assistants.

Unesco Scholarships — Unesco provided three scholarships — one for scientific translating and abstracting and two for photographic reproduction of documents — in 1952 for the training of suitable candidates in the special field of study relating to the Insdoc project.

Library & Equipment

The facilities of the library of the National Physical Laboratory which contains over 14,000 books and 200 periodicals with back volumes have been made available to Insdoc.

Nearly 300 scientific periodicals, together with back volumes for the last 5-10 years in some cases, have been ordered through Unesco. Unesco has set apart a sum of \$4,000 for supplying additional books during 1953.

New lists of journals for the Centre are now being compiled, keeping in view the requirements of the various national laboratories and other important scientific institutions. To enable Insdoc to act as a repository for all Indian scientific publications, a request was made to learned societies, Government departments, universities, scientific institutions and industrial concerns to send complimentary copies of their scientific publications or reports. All the national agencies have offered to co-operate and Insdoc is now receiving free of charge over 150 Indian periodicals.

Equipment — The following items of equipment valued at \$20,000 have been received from Unesco: dictating machines, microfilm readers, micro-card reader, microfilm filing cabinets, composing machines (Varityper and I.B.M.), equipment for developing, printing and enlarging photographic films, vacuum printing box for reflex copying, process camera and auxiliary equipment for preparing photo-offset plates, offset printing machine, paper guillotine, folding machine and wire stitching machine. Unesco also agreed to supply additional equipment worth \$13,000 in 1953. A request has been made to Unesco to place orders for a microfilm camera, developing equipment, and several microfilm readers.

Insdoc Services

The following services have been organized by the Centre:

1. Information service,
2. Document procurement service, and
3. Translation service

Information Service — Until 30 November 1953, 97 orders for bibliographies were received and 49 orders covering 128 typed sheets were completed. In most of these cases, complete bibliographies were compiled and supplied; in other cases, general information on the subject was supplied.

Document Procurement — Insdoc maintains this service for finding out and supplying copies of any scientific or technical article that may be required by scientific workers. If the particular journal is not available in India, a microfilm copy of the article is obtained by air from a foreign documentation centre at no additional charge to the requisitioner.

With the assistance of the Indian Library Association and scientific libraries throughout India, Insdoc has compiled for its own use a working catalogue of journals available in Delhi libraries and in the libraries of the various Indian universities and research institutions. This union catalogue is kept up to date and has proved very useful in locating scientific journals.

All the scientific institutions have extended to Insdoc the loan facilities of their libraries. This co-operation has been most helpful in enabling Insdoc to satisfy orders for copies of scientific papers with the least possible delay.

Orders for copies of 2,752 articles were received till the end of November 1953 and 1,933 orders were completed. This covers copies of articles on 2,605 ten-page microfilm strips and 8,000 sheets of photographic paper.

Orders for copies of Indian scientific papers were received from Australia, Egypt, France, Hungary, Nigeria and the United Kingdom, and were complied with.

Translation Service — Orders for 424 translations were received and 347 translations, comprising 3,693 typed pages, were supplied.

Document Copying — Scientific institutions have frequently sent documents to the Centre to be copied. Forty-eight requests were attended to, of which 27 per cent (by pages) were for microfilm copies and 73 per cent for paper photo-copies.

Rental of Microfilm Readers — To encourage scientists to make increased use of microfilms, it was decided, in consultation with Unesco to supply microfilm readers to institutions wanting them at a nominal rental of Rs. 5 per month. Twelve microfilm readers have so far been supplied and there is a large waiting list.

With a view to improving the availability of good microfilm readers in India, Insdoc has suggested to the Ordnance Factory, Dehra Dun, and the National Instruments Factory, Calcutta, certain features that should be incorporated in the microfilm readers which these factories are designing. The Ordnance Factory has completed the design of a reader incorporating these suggestions.

Charges — The following charges are made by Insdoc for its services:

BIBLIOGRAPHIES: Rs. 2 per typed page (foolscap, double spaced), with or without abstracts.

PHOTO-COPIES: Rs. 2 for the first two pages on photographic paper, with a further Re. 1 for each additional two pages.

MICROFILMS: Rs. 2 for the first ten pages, with a further Re. 1 for each additional ten pages.

TRANSLATIONS: Rs. 3 for each typed page of the English text (about 300 words), irrespective of the language of the original.

The scale of charges has been fixed at a low level so that the facilities of the Centre may be availed of by as many scientists as possible.

Bibliographical Bulletin — Unesco has made available to this Centre a photo-offset printing equipment. This will be used to publish a monthly journal entitled *Insdoc List of Current Scientific Literature*. This will include titles of scientific papers published in Indian and foreign journals, a list of translations available from Insdoc and other Commonwealth countries, translated titles (in English) of articles published in other European languages, and information about reports on special subjects.

Co-operation with Foreign Institutions

The work connected with the maintenance of the Commonwealth Scientific Office Catalogue of Translations and dissemination of information about these translations to Indian scientists is the responsibility of Insdoc. Particulars about a thousand translations made in various parts of the Commonwealth have recently been communicated to Indian scientific institutions.

The Centre has reciprocal arrangements with the Commonwealth Scientific & Industrial Organization of Australia, the National Research Council of Canada and the Institute des Fruits et Agrumes Coloniaux, Paris, for the free supply of microfilm copies of scientific papers published in these countries. India is a member of the International Federation for Documentation (FID) and Insdoc represents India on the Federation. Insdoc is also a member of the Association of Special Libraries and Information Bureaux, London (ASLIB).

IX

OTHER ACTIVITIES OF THE CSIR

WITH the object of promoting industrial development on a scientific basis the Council of Scientific & Industrial Research has undertaken several measures in addition to sponsoring and financing research in its own laboratories and in the laboratories of universities and research institutions. These measures cover a wide field and include formation of co-operative research associations, institution of fellowships and scholarships for the training of research personnel, technical advice, and the establishment of rural science centres. It is rather difficult to present a complete and connected account of all that the Council has done in this sphere. A few of the more important achievements are mentioned below.

Co-operative Research Associations

Co-operative research implies research organized by several units of an industry on a co-operative basis for their own benefit and for the benefit of the industry as a whole. The Government of India have promoted co-operative research with regard to primary products by establishing commodity committees financed by the compulsory levy of a cess or out of the proceeds of excise or export duty levied by Government as the case may be. The committees sponsor research aimed at securing improvements in the yield or quality of primary products. Barring a few instances, the committees have not undertaken any technological investigations aimed at expanding the field of utility of the commodities.

Most industrial concerns in India are too small to maintain research departments of their own. Their position can be strengthened through research aimed at improving processes and products. Further, there are many problems of a long-range character, the solution of which benefits industry as a whole and research on a co-operative basis is the only feasible course for improving their competitive position.

Taking these facts into consideration, the Council has interested itself in the task of educating industry to realize the advantages which will accrue through the formation of co-operative research associations. A model memorandum has been prepared and circulated to various industries and, where necessary, personal advice and assistance are given to facilitate the establishment of research associations. At the instance of the Council, the Government have exempted subscriptions to approved co-operative research associations from income tax.

These efforts have been successful in bringing home to industries the importance of research and the possibility of securing the benefits of research through co-operative effort. The establishment of co-operative associations are being considered by a few industries. The scope for research and investigation envisaged by such institutions covers the following:

- (a) Investigations on the manufacture and improvement of materials used in the industry and the allied trades or industries;
- (b) utilization of the products of the industry;
- (c) improvement of machinery and appliances used by the industry and the allied trades, and developing new machines and appliances for manufacturing, testing and recording purposes;
- (d) improvement of processes of manufacture with a view to securing greater efficiency, rationalization and reduction of costs, and
- (e) conditions of work, time and motion studies, fatigue and rest pauses, standardization of methods of work, conditioning of factories, and diseases and accidents arising specifically out of employment in the industry.

The following three research associations have been established during the last few years:

1. Ahmedabad Textile Industry's Research Association, Ahmedabad (1947)
2. Silk & Art Silk Mills' Research Association, Bombay (1950)
3. South India Textile Industry's Research Association, Coimbatore (1951)

The Council of Scientific & Industrial Research has assisted industry by undertaking research on specific projects referred to it by associations of various industries. The rubber industry has a proposal to form a Rubber Research Association with headquarters for research, development and testing in the National Chemical Laboratory; the paint, varnish, lacquer and pigment industry is considering a similar proposal. The Vanaspati Manufacturers' Association has, for several years, been financing research on the nutritional and dietary value of vanaspati (hydrogenated vegetable oils) through the Council's Vanaspati Research Committee. Since 1947, when the scheme was first instituted, the Association has contributed Rs. 1,74,544 for this purpose. More recently the Indian Coffee Board has instituted a scheme of research on coffee at the Central Food Technological Research Institute, Mysore, and an annual grant of Rs. 15,000 is made to the Council for this purpose. The Indian Central Oilseeds Committee has also been making financial contributions towards the cost of researches on the processing and utilization of vegetable oils. Last year, the Indian Council of Agricultural Research referred four schemes of research on leather for investigation at the Central Leather Research Institute, Madras. The expenditure to be incurred on this research is Rs. 1.374 lakhs spread over 3 years.

Exemption of Research Expenditure from Income Tax

In considering ways and means of financing research, the Chetty Committee on Industrial Research Planning (1945) observed: "Whatever the Government might do by way of building up of research organizations, every encouragement must be given for the establishment of research associations by various industries. The provisions of the income tax law, as they stand at present, are not conducive to giving encouragement to the manufacturer for making contributions for research associations or for establishing research departments in industrial manufacturing concerns." The Committee, therefore, recommended that steps should be

taken to amend the income tax law so that contributions to research associations or for industries for purposes of research may be considered as permissible items of expenditure. The Committee recommended that:

- (a) Any research expenditure of a capital character on laboratory, buildings, plant and machinery must be allowed over a period of five years or over the life of the assets, whichever is shorter, as a deduction from profits for income tax. In addition all current expenses such as wages, cost of materials, repairs and so forth must be allowed as and when incurred by the manufacturer. The allowance referred to relates to research expenditure carried out by the manufacturing concern on its own account;
- (b) any payment whether for a capital purpose or not made by the manufacturer to an approved research organization must be allowed as and when made as a deduction in computing the profits of the concern. Contributions to research carried out by a university or college on matters of concern to the manufacturer's business must similarly be allowed.

The Committee's recommendation was accepted by the Government and in 1946 the *Indian Income Tax Act* was amended to provide for expenditure of the following nature on research being claimed as an item of business expenditure in the computation of income tax leviable on a firm:

- (a) Expenditure on scientific research related to the business;
- (b) any sum paid to a scientific research association, university, college or any other institution for carrying on research related to their business, provided that such an institution was recognized for the purposes of this exemption by the prescribed authority.

The *Act* was further amended in 1950 to exempt direct income of a research association also from income tax. The Council of Scientific & Industrial Research was recognized as the authority to accord recognition to institutions and it was agreed that cases of dispute as to whether a particular expenditure constituted expenditure on research or not should be referred to the Council for advice.

Exemption of Import Duty on Research Equipment

On the recommendation of the Council, the Ministry of Finance has exempted from customs duty the import of scientific equipment falling within items 77(2) and 77(4) of the Indian Customs Tariff. The exemption is granted to (i) research laboratories receiving financial assistance from the Government, (ii) co-operative research laboratories, (iii) science departments of universities, (iv) science colleges affiliated to universities teaching up to the master of science degree or above, (v) colleges of engineering and technology providing degree courses, (vi) medical colleges and (vii) agricultural colleges. The production of a certificate from the Director General of Industry & Supply to the effect that such equipment are not manufactured in India is necessary for claiming the exemption.

The restriction that imported equipment should come under the category 77(2) and 77(4) of the Indian Customs Tariff has created some difficulty in interpretation. The Ministry of Finance has been requested

to relax this condition and to exempt all scientific equipment imported for *bona fide* research from customs duty.

Excise Duty on Alcohol — The Council has recommended that Central and State Governments should exempt alcohol required for research purposes from excise duty. This recommendation has been accepted and institutions, whose sole aim is advancement of science, are allowed the privilege of obtaining alcohol duty-free for scientific purposes. Reliable firms having well-equipped research laboratories and manned by qualified scientific personnel are also eligible to the concession if their activities are devoted to research development.

The attention of Central and State Governments has also been drawn to the desirability of encouraging the production of chemicals and pharmaceuticals as cheaply as possible and to achieve this, the Council has recommended that the duty levied on alcohol used for industrial purposes should not, as a rule, exceed the primary cost of production of alcohol.

The expert committee appointed by the Government of India has considered the recommendation. The suggestions of the expert committee have been circulated to the State Governments.

TABLE 1 — CSIR FELLOWSHIPS AND SCHOLARSHIPS 1952-53

LABORATORY	1952 SCHOLARSHIP	1953	
		FELLOWSHIP	SCHOLARSHIP
1. National Chemical Laboratory, Poona	Chemical engineering	Organic chemistry	Chemical engineering
2. National Metallurgical Laboratory, Jamshedpur	Ore-dressing & mineral beneficiation	—	—
3. Fuel Research Institute, Jaegera	Combustion research	Coal tar and by-products	Combustion research
4. Central Glass & Ceramic Research Institute, Calcutta	Glass	—	Glass
5. Central Drug Research Institute, Lucknow	Synthetic or plant chemistry	Endocrinology	Synthetic or plant chemistry
6. Central Food Technological Research Institute, Mysore	Quality control Loss of nutrients through insect infection	—	Quality control: Loss of nutrients through insect infection
7. Central Leather Research Institute, Madras	Synthetic tanning materials	—	Synthetic tanning materials
8. Central Road Research Institute, Delhi	—	—	The grading of the mineral constituents in relation to the preparation of cement and bituminous concrete
9. Central Electro-Chemical Research Institute, Karakul	—	—	Electrochemistry
10. Central Building Research Institute, Roorkee	—	Pre-stressed concrete	Soil mechanics and foundation engineering

CSIR Fellowships & Scholarships

The Scientific Manpower Committee (1948) had recommended the institution of scholarships and fellowships in research departments of universities and at other research institutions, including the national laboratories, with a view to impart training in research and to enhance the standard of research in the country. The implementation of the recommendation in so far as it related to universities and research institutions was entrusted to the Ministry of Education and the Ministry of Natural Resources & Scientific Research but the institution of fellowships and scholarships in national laboratories was deferred as the laboratories were then in the formative stage. In 1952, when many of the laboratories had started functioning, the Council announced 10 fellowships and 10 scholarships (increased to 11 in 1953) of the value of Rs. 250 and Rs. 150 per mensem without allowances, and allocated them to different laboratories. The minimum qualification for the fellowship is a doctorate degree, that for the scholarship, a master's degree or equivalent qualification. Awards are made on a year-to-year basis subject to renewal in the event of satisfactory progress.

The subjects selected for the awards in 1952 and 1953 and the laboratories in which they were made tenable are shown in Table 1.

Burmah-Shell & Assam Oil Co. Scholarships

In 1951, Messrs Burmah-Shell Oil Storage & Distributing Co. and Messrs Assam Oil Co. Ltd. offered to institute two scholarship schemes to provide opportunities to selected students for training in specified subjects in Commonwealth countries, facilities for which are not available in India. Students eligible for the scholarships should have completed the university course and given evidence of capacity for scientific investigation and technical work.

The schemes aim at providing (1) training in specialized subjects for which there is an urgent demand either from Government or from industry; (2) training in specialized subjects required for manning Government sponsored industrial undertakings; and (3) advanced studies and specialized training of personnel required to man educational and technical institutions, research institutes and public utility concerns.

The Burmah-Shell scheme provides for instituting every year (1) two scholarships tenable for 4 years each at Loughborough college (approx. value Rs. 50,000 per annum; administered by Burmah-Shell) and (2) three scholarships, ordinarily tenable for 2 years in any institution in the Commonwealth (approx. value, Rs. 50,000 per annum; administered by CSIR). The Assam Oil Co. scheme provides for the institution every year of 7 scholarships ordinarily tenable for 2 years in Commonwealth countries (approx. value Rs. 1 lakh per annum; administered by CSIR).

CSIR scholars selected under both schemes receive a stipend of £382 (or \$1,500 in Canada) per annum payable in monthly instalments + certain allowances to cover the cost of books, essential apparatus, study tours, etc. Tuition and examination fees are paid direct to institutions to which the scholars are assigned and second tourist class sea passage both ways, whichever is available, is generally arranged.

TABLE 2 — BURMAH-SHELL & ASSAM OIL CO. SCHOLARSHIPS

SUBJECT	1952*		1953†	
	BURMAH-SHELL	ASSAM OIL CO.	BURMAH-SHELL	ASSAM OIL CO.
Petroleum technology	1	—	—	—
Highway engineering	1	—	1	—
Physics in petroleum technology	—	1	—	—
Dam design & construction	—	1	1	—
Electrical engineering	—	2	—	—
Refinery engineering	—	1	—	—
Aviation engineering	—	1	—	1
Agricultural engineering	—	—	1	—
Prestressed concrete, avoidance of foundation failures	—	—	—	1
Separation of hydrocarbons from natural and cracked mineral products	—	—	—	1
Antibiotics	—	—	—	1
Design and construction of transformers; rotary converters & electric generators	—	—	—	1
Chemotherapy	—	—	—	1

* Two of the selected candidates were disqualified by the Medical Board; one scholar was assigned to Canada and the remaining seven to U.K.

† One scholar was assigned to Canada and the other nine to U.K.

Selections are made by a Committee on which Burmah-Shell and Assam Oil Co. are represented by one nominee each and selected candidates have to appear before a medical board. The subjects selected for the award of scholarships and the number of scholars selected are indicated in Table 2.

Technical Intelligence & Advice

The increasing emphasis on the utilization of indigenous raw materials, the rapid pace of industrialization and the changing pattern of Indian economy have stimulated interest on a variety of subjects on which information is not readily available, and created the need for an agency to handle enquiries from *entrepreneurs*, institutions and individuals. The Council of Scientific & Industrial Research fulfils this need and supplies information, through its organizations, on enquiries referred to it. The subject on which information is sought covers a wide field — from the occurrence and distribution of a drug plant to technical advice on commercial possibilities of new ventures. The Council refers some of the enquiries to the laboratories most appropriate to handle them; information on others is supplied from the ledgers built up in the technical divisions, yet in other cases literature search is undertaken. Detailed studies are sometimes called for as in the case of the advice rendered to the Madhya Bharat Government in appraising the work of the Jiwaji Industrial Research Laboratory and the lines on which the laboratory

should be developed; or advice rendered to the Industrial Finance Corporation of India in disposing of applications for financial assistance to various firms. In every case, efforts are made to provide full information as promptly as possible.

A guide to the information services of the Council is being compiled to assist enquirers to refer their enquiries to the appropriate section or laboratory of the Council from which the information they need can be secured.

The Central Office of the Council also handles a number of enquiries from individuals, Government and industrial concerns. These enquiries relate to the raw material resources of the country, aspects of industrial utilization, small-scale and cottage industries.

The first Reviewing Committee in their Report observed: "Industry does not appear to be sufficiently aware of the facts of the Intelligence Service of the Council and the extent to which it can help them in their technical problems. The Committee notes that provision for an intelligence section is being made in all the national laboratories to impart information about the particular subject connected with the particular laboratory.

Information Divisions have been established in the national laboratories for providing advice to industry on subjects which come within their purview. In some cases, analytical and investigatory work has to be undertaken to assist industry. The Council has laid down a policy to guide national laboratories in regard to such technical aid. The broad outlines of the policy are:

(a) National laboratories would not, as a matter of policy, undertake routine testing for which facilities exist in the Government Test House and other similar institutions, except when such routine testing forms a part of a survey or investigation connected with the issue of certificates of standardization. Special tests for which facilities at existing institutions are not available may be undertaken by national laboratories, provided they do not interfere with their normal work. The certificate for tests will clearly state that it relates only to the sample submitted and examined;

(b) for off-hand technical advice to industry, where no investigations need to be undertaken and no written report is necessary, no fees would ordinarily be charged. Industry would, however, be required to pay the travelling expenses of the officers concerned;

(c) fees would be charged for technical advice to industry involving minor investigations and submission of a written report, the quantum of such fees being determined by the directors concerned, if necessary after consulting the Director, Scientific & Industrial Research. In addition to these fees, travelling expenses incurred by officers would be recovered from the industrial organization concerned;

(d) in the case of major problems involving regular investigations, a scheme of research would be drawn up by the director of the laboratory concerned in consultation with the Director, Scientific & Industrial Research and suitable provision made therein for the sharing of any royalties arising out of patents, etc., which may be taken out as a result of investigations. Any staff appointed under such schemes will be purely temporary and the salary for the same, as well as incidental charges for chemicals, apparatus, gas, water, etc., will have to be borne by industry. In all such cases, it would be desirable to draw up a regular agreement to avoid misunderstanding of terms at a later stage.

Vigyan Mandir

The Council of Scientific & Industrial Research proposes to start rural science centres for conveying the benefits of science to village artisans and farmers. A rural science centre — Vigyan Mandir — has been established in the vicinity of Kapasera village (4 miles from Palam on the Delhi-Najafgarh Road) as an experimental measure. The centre is equipped for soil and water analysis, control of plant pests and diseases, examination of human diseases and nutritional deficiencies, and dissemination of scientific information with the help of films, lantern slides, charts and popular science talks.

One junior scientific officer, one laboratory assistant and one bearer constitute the staff. A part-time medical officer visits the place thrice a week.

It is intended to extend the scheme to other places in the light of the experience gained in the working of the first centre.

X

FINANCE

THE activities of the Council of Scientific & Industrial Research are financed mainly by annual grants from the Central Government. The Board of Scientific & Industrial Research was established in 1940 with a grant of Rs. 10 lakhs spread over two years. The grant was raised to Rs. 10 lakhs per year when the "Industrial Research Fund" was constituted "for the purposes of fostering industrial development in the country" by a resolution passed by the Legislative Assembly on 14 November 1941, and the Council of Scientific & Industrial Research was set up as an autonomous body "to implement and give effect to the resolution creating the Industrial Research Fund".

The period following the establishment of the Council was one of intense constructive activity. Plans for the construction of a network of national laboratories were formulated and research under the grants-in-aid scheme was enlarged. Additional funds became necessary and the Government generously extended monetary support to the expanding scientific work of the Council. In his budget speech to the Legislative Assembly on 29 February 1944, the Member for Finance announced: "In connection with industrial research, we have made provision for a grant of Rs. 10 lakhs for the construction and equipment of Glass and Fuel Research Laboratories and for general planning for other institutions. The Council of Scientific & Industrial Research has done valuable work within the limits of the funds allotted to it by Government, and the Government of India have now agreed to the Council drawing up plans for a co-ordinated scheme for the advancement of research on the assumption that rupees one crore will be forthcoming towards capital expenditure on a chain of research institutions. The institutions in contemplation, in addition to the two I have mentioned, are a National Physical Laboratory, the National Chemical Laboratory and a National Metallurgical Laboratory. The balance of rupees one crore will be spread over a period of three or four years after the cessation of hostilities. This step will, I am sure, be regarded as a practical expression of Government's resolve to foster the development of Indian industry and should, at the same time, serve as an incentive to provide enterprise to come forward and support industrial research."

The advent of the National Government in 1947 gave a further impetus to the Council's activities and many plans for the expansion of scientific research were put into effect as a result of the continuing support of the Government. Table 1 gives a statement of the grants made by the Central Government since 1942-43. Table 2 gives the recurring expenditure.

The Council has succeeded in enlisting the support of industry for its expanding activities. State Governments have come forward with gifts of valuable lands and buildings for the establishment of national laboratories. Table 3 gives a list of donations made to the Council for various purposes.

TABLE 1 — GRANTS FROM CENTRAL GOVERNMENT
1942/43-1953/53

				RECURRING (Rs.)	CAPITAL (Rs.)
1942-43	...	...	...	11,00,000*	—
1943-44	...	...	...	10,00,000	—
1944-45	...	...	...	15,00,000	70,75,000
1945-46	...	...	...	15,00,000	—
1946-47	...	...	...	23,23,000	—
1947-48	...	...	...	30,36,000	—
1948-49	...	...	...	43,98,000	17,05,000
1949-50	...	...	...	48,14,400	60,00,000
1950-51	...	...	...	73,00,000	75,00,000
1951-52	...	...	...	1,08,90,000	75,00,000
1952-53	...	...	...	1,40,75,000	60,00,000
1953-54	...	...	...	1,73,50,000†	60,00,000

* Includes a grant of Rs. 1 lakh for specific problems.

† Includes a grant of Rs. 2 lakhs for a specific scheme.

TABLE 2 — RECURRING EXPENDITURE 1942/43-1952/53

				EXPENDITURE (Rs.)
1942-43	...	...	...	6,95,611
1943-44	...	...	...	12,65,676
1944-45	...	...	...	12,77,011
1945-46	...	...	...	17,24,499
1946-47	...	...	...	21,48,621
1947-48	...	...	...	28,05,578
1948-49	...	...	...	37,56,618
1949-50	...	...	...	46,59,689
1950-51	...	...	...	68,73,651
1951-52	...	...	...	94,27,408
1952-53	...	...	...	1,29,28,765

Table 4 gives a statement of capital expenditure incurred and commitments entered into till 30 September 1953 in connection with the building and equipment of national laboratories.

The Council also receives grants from various sources for specified purposes. Thus, during the current year, a sum of Rs. 30,000 was received from the Vanaspathi Manufacturers' Association for research on the nutritive value of vanaspathi; Rs. 10,000 from the Indian Central Oil-seeds Committee for research on vegetable oils; Rs. 15,000 from the

TABLE 3 — DONATIONS IN CASH PAID OR PROMISED AND ESTIMATED VALUE OF LANDS AND BUILDINGS RECEIVED BY CSIR TOWARDS THE ESTABLISHMENT OF NATIONAL LABORATORIES

LABORATORY	DONOR	CASH		LAND		BUILDINGS		TOTAL
		Rs.	Details	Estimated value, Rs.	Details	Estimated value, Rs.		
National Physical Laboratory, New Delhi	Central Government	—	67 acres	10,05,000	—	—	Rs. 10,05,000	
National Chemical Laboratory, Poona	Sir Dorabji Tata Trust Tata Iron & Steel Co. Bombay Government	4,15,000 4,16,000 —	— — 435 acres for Rs. 6 lakhs	— — 30,00,000	— — —	— — —	38,31,000	
National Metallurgical Laboratory, Jamshedpur	Sir Ratan Tata Charities Indian Steel & Wire Products Co. Indian Met. Association Raja of Jharia	11,70,000 1,00,000 10,000 —	— — — 150 acres	— — — 4,50,000	— — — —	— — — —	12 80,000 4,50,000	
Fuel Research Institute, Jeel-gora	Shri R. K. Aggarwal	2,00,000	—	—	—	—	—	
Central Glass & Ceramic Research Institute, Calcutta	Sir U. N. Brahmachari U.P. Glass Works, Ltd. Bengal Glass Mfg. Ass. Mysore Government	10,000 10,000 10,000 —	— — — 150 acres	— — — 60,00,000	— — — Cheluvamba Mansion	— — — 65,00,000	2,30,000	
Central Food Technological Research Institute, Mysore	Shri Mohan Singh U.P. Government	5,000 —	— 9 acres	— 13,50,000	— Chattar Manzil Palace	— 25,00,000	1,25,05,000 38,50,000	
Central Drug Research Institute, Lucknow	Archbishop of Delhi	—	31 acres	5,00,000	—	—	5,00,000	
Central Road Research Institute, Delhi	Dr. Rm. Alagappa Chettiar	15,00,000	300 acres	6,00,000	—	—	21,00,000	
Central Electro-Chemical Research Institute, Karaikudi	Madras Government	—	65 acres	3,00,000	—	—	—	
Central Leather Research Institute, Madras	Leather Industry	10,00,000	—	—	—	—	13,00,000	
Central Salt Research Station, Bhavnagar	Saurashtra Government	—	—	2,00,000	—	15,00,000	17,00,000	
Central Electronics Engineering Research Institute, Pilani	Shri G. D. Birla	21,00,000 (promised)	—	—	—	—	21,00,000	
Mechanical Engineering Research Institute, Calcutta	Shri Jalan	21,00,000 (promised)	—	—	—	—	21,00,000	
Coal Survey Stations	State Governments	—	—	3,00,000	—	7,00,000	10,00,000	
GRAND TOTAL:		92.62,000	1,37,05,000		1,12,00,000		223 3,41,67,000	

TABLE 4—NATIONAL LABORATORIES—EXPENDITURE ON BUILDINGS & EQUIPMENT UP TO 30 SEPTEMBER 1953

LABORATORY	CONSTRUCTION	SERVICES	EQUIPMENT	BOOKS, JOURNALS, FURNITURE, ETC.	TOTAL
	Rs.	Rs.	Rs.	Rs.	Rs.
National Physical Laboratory	46,78,000	8,87,000	29,34,000	6,89,000	91,88,000
National Chemical Laboratory	42,88,100	9,81,900	16,97,000	8,23,800	77,90,800
National Metallurgical Laboratory	18,65,943	9,12,754	21,40,120	3,47,853	52,66,670
Fuel Research Institute	12,03,887	7,81,847	9,35,230	3,66,577	32,87,541
Central Glass & Ceramic Research Institute	12,66,100	3,33,900	10,52,000	1,95,200	28,47,200
Central Food Technological Research Institute	1,22,882	2,02,232	8,47,071	3,09,767	14,81,952
Central Drug Research Institute	7,67,212	3,98,193	8,91,148	3,60,342	24,16,895
Central Road Research Institute	14,88,552	3,95,595	5,65,794	1,58,892	26,08,533
Central Electro-Chemical Research Institute	12,46,954	5,21,860	2,99,708	2,41,503	23,10,025
Central Leather Research Institute	19,47,000	3,34,600	5,43,000	2,02,100	30,26,700
Central Building Research Institute	9,67,923	4,03,986	5,53,578	1,66,929	20,92,416
Coal Survey Stations	2,49,010	1,27,062	1,50,634	68,401	5,95,107
TOTAL:	2,00,91,563	62,80,929	1,26,09,283	39,30,064	4,29,11,839

Indian Coffee Board for research on Coffee at the Central Food Technological Research Institute, Mysore; Rs. 64,000 from the Ministry of Food & Agriculture for analytical work at the Central Food Technological Research Institute, Mysore, in connection with the Fruit Products Control Order and Rs. 1,50,000 from the Burmah-Shell and Assam Oil Companies for the award of scholarships.

Among other sources of income to the Council may be mentioned fees received by national laboratories for analytical work and technical advice, sale of publications and periodicals, and royalties and premia for rights to exploit Council's patents and processes. The receipts from such miscellaneous sources during the year 1953-54 was Rs. 5,08,000. The income under this head forms only a small part of the total receipts of the Council.

Table 5 gives the budget for 1952-53 and the estimated budget for 1953-54. The major items of expenditure are Rs. 1,30,81,800 on the

national laboratories (NPL, Rs. 26,58,400; NCL, Rs. 20,50,300; NML, Rs. 11,85,000; FRI, 12,30,900; CGCRI, Rs. 7,19,300; CFTRI, Rs. 8,81,800; CDRI, Rs. 11,80,100; CRRI, Rs. 5,92,000; CECRI, Rs. 2,67,400; CLRI, Rs. 4,29,700; CBRI, Rs. 4,29,600; and CSS, Rs. 3,56,400), and Rs. 15,29,000 under grants-in-aid for scientific, industrial and engineering research in universities and research institutions.

Research Expenditure — The Industrial Research Planning Committee appointed by Council early in 1944 recommended the levy of a cess on industrial production for providing a steady source of revenue for research expenditure. Although Government did not accept the recommendation, provision for a levy is contained in the *Industries (Development and Regulation) Act of 1951* for financing Development Councils for scheduled industries. The functions assigned to the Development Councils include: “(1) Promoting or undertaking inquiry as to materials and equipment and as to methods of production, management and labour utilization, including the discovery and development of new materials, equipment and methods and of improvements in those already in use, the assessment of the advantages of different alternatives and the conduct of experimental establishments and of tests on a commercial scale. (2) Promoting the adoption of measures for increasing the productivity of labour, including measures for securing safer and better working conditions and the provision and improvement of amenities and incentives for workers.”

Similarly, the objects of the Coal Board set up under the *Coal Mines Conservation and Safety Act* includes “the prosecution of research work connected with safety in coal mines and conservation and utilization in coals”. The Board has agreed to provide Rs. 5 lakhs to the Council of Scientific & Industrial Research during 1953-54 for financing research on coal washing and coal utilization at the Fuel Research Institute, Jealgora. The Indian Council of Agricultural Research, which is partly financed through a cess on exports of raw hides and skins, has agreed to finance research schemes on leather at the Central Leather Research Institute, Madras, at a cost of Rs. 1.374 lakhs spread over three years.

TABLE 5 — REVISED BUDGET FOR 1952-53 AND BUDGET ESTIMATES FOR 1953-54

RECEIPTS			EXPENDITURE		
PARTICULARS	REVISED BUDGET 1952-53	ESTIMATES FOR 1953-54	PARTICULARS	REVISED BUDGET 1952-53	ESTIMATES FOR 1953-54
	Rs	Rs		Rs	Rs
1. Opening Balance	31,77,700	14,76,500	A — Central Office Administration	8,80,100	9,05,900
2. (i) Lump sum grant from Cen- tral Government	1,40,00,000	1,71,50,000	D — Publications Division:		
(ii) Grant for Insdoc	1,49,800	2,00,000	DA — Dictionary	2,99,000	2,70,500
(iii) Grant for Synthetic Rice Scheme	15,000	—	DB — Journal	1,04,100	1,35,000
(iv) Amount from Election Com- missioner for supply of in- delible ink during General Elections	40,000	34,000	DC — Other publications	1,02,000	1,20,000
3. Contribution from other sources:			E — Grants-in-aid		
(i) Vanaspathi Manufacturers' Association	33,700	30,000	(i) Research schemes	17,72,400	12,74,000
(ii) Indian Central Oilseeds Com- mission	11,600	10,000	(ii) Board of Engineering Re- search	45,000	2,55,000
(iii) Indian Coffee Board	15,000	15,000	F — (i) Committees: Research & <i>ad hoc</i>	1,39,300	1,54,300
(iv) Burmah-Shell Oil Co. & Assam Oil Co. for scholar- ships	75,000	1,50,000	(ii) Board of Engineering Re- search	17,200	25,000
(v) Ministry of Food & Agricul- ture for implementation of Food Products Control Order	—	64,000	G — Deposits and advances	7,83,700	6,72,700
4. Income from investments	60,000	40,000	H — Suspense	60,000	45,400
5. Income from other sources:	4,63,200	5,08,000	J — Superannuation allowances & pensions	1,000	2,000
Receipts, routine testing in laboratories, publications, new equipment, receipts			PL — National Physical Labora- tory	26,58,400	24,71,700
			Insdoc	1,49,800	2,00,000
			CL — National Chemical Labora- tory	20,50,300	19,96,600
			ML — National Metallurgical Labo- ratory	11,85,000	11,85,500
			FRI — Fuel Research Institute	12,30,900	14,28,900

6. Deposits and advances
7. Suspense

GL — Central Glass & Ceramic Research Institute	4,52,700 70,400	4,96,400 95,800	7,19,300	7,62,300
FT — Central Food Technological Research Institute			8,81,800	10,36,400
DRG — Central Drug Research Institute			11,80,100	12,04,900
RRI — Central Road Research Institute			5,92,000	6,49,900
ECI — Central Electro-Chemical Research Institute			2,67,400	5,44,600
LRI — Central Leather Research Institute			4,29,700	7,17,000
BRI — Central Building Research Institute			4,29,600	6,38,200
CSS — Coal Survey Stations			3,56,400	4,45,800
GEN — General Planning			82,000	70,000
TR — Training of personnel			20,000	25,000
FSS — Fellowships and scholarships			60,000	60,000
Insurance of equipment			10,000	10,000
Scholarships: Burmah-Shell Oil Co., and Assam Oil Co.			75,000	1,50,000
Amount transferred to capital account for the construction of office building			5,75,000	2,10,000
Depreciation fund			—	8,91,900
National Research Development Project			—	1,50,000
Anticipated closing balance			1,71,56,700	1,87,09,100
TOTAL:	1,86,33,200	2,02,00,600	14,76,500	14,91,500
			1,86,33,200	2,02,00,600

FINANCE

APPENDICES

APPENDIX I

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APPENDIX II

(a) RESEARCH SCHEMES

1. Alkaloids from *Chandni* roots — DR. R. H. SIDDIQUI, Aligarh University, Aligarh (1940-44).
2. Purification of glass sands — DR. A. NADEL, Banaras Hindu University, Banaras (1940-48).
3. Manufacture of carbon disulphide from sulphur and charcoal — DR. N. N. GODBOLE, Banaras Hindu University, Banaras (1940-49).
4. *Neem* oil as a denaturant of alcohol — DR. N. N. GODBOLE, Banaras Hindu University, Banaras (1940-49).
5. Manufacture of formaldehyde — DR. J. C. GHOSH, Indian Institute of Science, Bangalore (1940-44).
6. Manufacture of graphite electrodes — PROF. K. ASTON, Indian Institute of Science, Bangalore (1940-43).
7. Manufacture of condensers and resistances — PROF. K. ASTON, Indian Institute of Science, Bangalore (1940-43).
8. Carborundum and its finished products — PROF. K. ASTON, Indian Institute of Science, Bangalore (1940-43).
9. Manufacture of organo-arsenical compounds — PROF. P. C. GUHA, Indian Institute of Science, Bangalore (1940-45).
10. Method of extraction of vegetable dyes — DR. K. VENKATARAMAN, Bombay University, Bombay (1940-43).
11. Cracking of vegetable oils — DR. T. MEHTA, Bombay University, Bombay (1940-42).
12. Plastics from vegetable oils — PROF. M. N. GOSWAMY, Calcutta University, Calcutta (1940-42).
13. Splitting of oils — PROF. M. N. GOSWAMY, Calcutta University, Calcutta (1940-45).
14. Extraction of ionone from lemon grass — PROF. M. N. GOSWAMY, Calcutta University, Calcutta (1940-43).
15. Utilization of commercial xylene for Dettol type of disinfectants — DR. P. K. BOSE, Calcutta University, Calcutta (1940-42).
16. Manufacture of atropine, emetine, etc. — PROF. P. C. MITTER, Calcutta University, Calcutta (1940-43).
17. Preparation of enterovioform — PROF. P. C. MITTER, Calcutta University, Calcutta (1940-45).
18. Extraction of potash salts from molasses — PROF. P. RAY & MR. B. M. MUKERJI, Calcutta University, Calcutta (1940-43).
19. Devising a method for testing the quality of optical glass — DR. S. C. SARKAR, Calcutta University, Calcutta (1940-42).
20. Survey of the production of insulation materials and dielectrics for high frequencies — PROF. S. K. MITRA, Calcutta University, Calcutta (1940-44).

21. Design of electro-acoustical and high frequency apparatus — PROF. S. K. MITRA, Calcutta University, Calcutta (1940-45).
22. Manufacture of vacuum pumps, compressors and refrigeration machines — PROF. M. N. SAHA, Calcutta University, Calcutta (1940-48).
23. Splitting of oils — DR. M. QURESHI, Osmania University, Hyderabad (Dn.), (1940-46).
24. Manufacture of high grade refractory clays and pots — PROF. M. L. JOSHI, Punjab University, Lahore (1940-46).
25. Manufacture of optical glass — PROF. M. L. JOSHI, Punjab University, Lahore (1940-45).
26. Production of acids generally from molasses — DR. J. N. RAY, Punjab University, Lahore (1940-42).
27. Photosensitizing dyestuffs — PROF. M. N. DOJA, Patna University, Patna (1940-44).
28. Manufacture of cheap radio sets and volume controls — DR. G. B. TOSHIWAL, Allahabad University, Allahabad (1941-46).
29. Manufacture of phosphorus — DR. J. C. GHOSH, Indian Institute of Science, Bangalore (1941-45).
30. Manufacture of urea — DR. J. C. GHOSH, Indian Institute of Science, Bangalore (1941-43).
31. Manufacture of potassium chlorate — DR. J. C. GHOSH & DR. S. K. K. JATKAR, Indian Institute of Science, Bangalore (1941-43).
32. Manufacture of sodium cyanide — DR. J. C. GHOSH & DR. S. K. K. JATKAR, Indian Institute of Science, Bangalore (1941-43).
33. Beneficiation of (i) graphite, (ii) gypsum, (iii) phosphates, (iv) chromite and fluorite from the Trichinopoly area — DR. J. C. GHOSH, DR. M. R. A. RAO & DR. B. SANJIVA RAO, Indian Institute of Science, Bangalore (1941-50).
34. National collection of type cultures — MR. M. SREENIVASAYA, Indian Institute of Science, Bangalore (1941-51).
35. Standardization of dye extracts from the barks of *Butea frondosa* — MR. M. N. DE, Government, Silk Institute, Bhagalpur (1941-45).
36. Compilation of a list of organic and inorganic materials for dyestuff industry — DR. K. VENKATARAMAN, Bombay University, Bombay (1941-42).
37. Preparation of vat dyes — DR. K. VENKATARAMAN, Bombay University, Bombay (1941-50).
38. Analysis of coal-tar products — DR. M. R. MANDLEKAR, Bombay University, Bombay (1941-42).
39. Manufacture of aniline from chlorobenzene — DR. G. P. KANE, Bombay University, Bombay (1941-45).
40. Survey and utilization of cellulose-bearing materials (other than cotton) of India — DR. NAZIR AHMED (later MR. D. L. SEN), Cotton Technological Laboratory, Bombay (1941-48).
41. Manufacture of photographic materials in India — PROF. G. R. PARANJPE, Institute of Science, Bombay (1941-46).
42. Preparation of mono and dialkyl anilines — MR. B. C. ROY, Calcutta University, Calcutta (1941-44).

43. Extraction of rare earths from monazite sands — DR. P. B. SARKAR, Calcutta University, Calcutta (1941-48).
44. Manufacture of X-ray transformers — MR. B. B. BHOWMIK, Randon House, Kalighat (1941-43).
45. Manufacture of graphite crucibles — DR. S. L. MUKERJI, Salkia, Howrah (1941-46).
46. Coal blending and coking research — Chairman, Coal Blending & Coking Research Subcommittee, Jamshedpur (1941-).
47. Preparation of diethylphthalate — DR. S. S. JOSHI, Banaras Hindu University, Banaras (1942-45).
48. Manufacture of carbon disulphide — DR. J. C. GHOSH, Indian Institute of Science, Bangalore (1942-45).
49. Manufacture of titanium dioxide — DR. J. C. GHOSH & DR. K. R. KRISHNASWAMI, Indian Institute of Science, Bangalore (1942-45).
50. Manufacture of hydrogen peroxide — DR. J. C. GHOSH & DR. K. R. KRISHNASWAMI, Indian Institute of Science, Bangalore (1942-49).
51. Manufacture of synthetic adrenaline — PROF. P. C. GUHA, Indian Institute of Science, Bangalore (1942-45).
52. Pilot plant experiments on aniline, nitrobenzene, etc.— PROF. P. C. GUHA, Indian Institute of Science, Bangalore (1942-45).
53. Treatment and utilization of industrial wastes, with special reference to the textile mill wastes of Ahmedabad — PROF. V. SUBRAHMANYAN, Indian Institute of Science, Bangalore (1942-49).
54. Manufacture of good quality vegetable rennet — PROF. V. SUBRAHMANYAN, Indian Institute of Science, Bangalore (1942-48).
55. Sulphonation of vegetable oils — DR. K. G. NAIK, Baroda College, Baroda (1942-44).
56. Economic utilization of Hongay oil and kokum butter — DR. R. D. DESAI & DR. P. N. JOSHI, Bombay University, Bombay (1942-44).
57. Cutting and testing of quartz crystals — DR. D. M. BOSE, Bose Research Institute, Calcutta (1942-44).
58. Manufacture of radio valves — PROF. S. K. MITRA, Calcutta University, Calcutta (1942-).
59. Manufacture of graphite crucibles — PROF. M. L. JOSHI, Punjab University, Lahore (1942-46).
60. Manufacture of X-ray tubes and kenotrons — DR. P. K. KICHLU, Punjab University, Lahore (1942-46).
61. Manufacture of glandular products and utilization of waste products from sharks — DR. B. B. DEY, Presidency College, Madras (1942-49).
62. Utilization of waste mica of Bihar — PROF. R. C. RAY, Patna University, Patna (1942-46).
63. Agar agar from sea weeds — DR. K. L. MOUDGIL, Department of Industries, Travancore (1942-43).
64. Manufacture of ceramic glazes and colours — DR. G. GOPALA RAO, Andhra University, Waltair (1942-50).
65. Manufacture of potassium perchlorate — DR. S. S. JOSHI, Banaras Hindu University, Banaras (1943-44).
66. Manufacture of polythenes by hydrogenation of rubber latex (physical and chemical properties of rubber latex) — DR. J. C. GHOSH,

- DR. B. SANJIVA RAO, DR. GOVIND RAU & DR. M. R. A. RAO, Indian Institute of Science, Bangalore (1943-51).
67. Manufacture of butadiene — DR. J. C. GHOSH & DR. S. K. NANDI, Indian Institute of Science, Bangalore (1943-48).
 68. Rubber-lined equipment for chemical industry — DR. J. C. GHOSH, DR. M. R. A. RAO & DR. B. SANJIVA RAO, Indian Institute of Science, Bangalore (1943-46).
 69. Production of industrial enzymes — MR. M. SREENIVASAYA, Indian Institute of Science, Bangalore (1943-50).
 70. Manufacture of synthetic dyes from catechin — DR. K. VENKATARAMAN, Bombay University, Bombay (1943-46).
 71. Manufacture of Sulphur Black from benzene — DR. R. D. DESAI & DR. P. N. JOSHI, Bombay University, Bombay (1943-46).
 72. Cultivation of *Palmarosa* grass — Director of Industries, Government of Bombay (1943-44).
 73. Manufacture of gelatin — DR. MATA PRASAD, Institute of Science, Bombay (1943-48).
 74. Desulphurization of coal — DR. J. K. CHOWDHRY, Bose Research Institute, Calcutta (1943-50).
 75. Radium contents of Indian minerals and mineral springs — DR. B. D. NAG CHOWDHURY, Calcutta University, Calcutta (1943-44).
 76. Ionospheric investigations — PROF. S. K. MITRA, Calcutta University, Calcutta (1943-).
 77. Theoretical investigations on the upper atmosphere — PROF. M. N. SAHA, Calcutta University, Calcutta (1943-51).
 78. Low temperature carbonization of coal — DR. B. N. GHOSH, Calcutta University, Calcutta (1943-48).
 79. Manufacture of duplicating ink — MISS S. RAM, New Delhi (1943).
 80. Washability of Indian coals — DR. C. FORRESTER, Indian School of Mines, Dhanbad (1943-50).
 81. Manufacture of permanent magnets — Tata Iron & Steel Co. Ltd., Jamshedpur (1943-45).
 82. *Khus* roots — MR. C. T. ITYACHAN, Dept. of Agriculture, Madras (1943-45).
 83. Manufacture of direct cotton colours — DR. B. B. DEY, Presidency College, Madras (1943-50).
 84. Cultivation of *Patchouli* in the Madhya Pradesh — Director of Industries, Madhya Pradesh, Nagpur (1943-44).
 85. Development of copper silicon bronzes — DR. D. R. MALHOTRA, B.B. & C.I. Railway Workshop, Ajmer (1944-46).
 86. Chemical investigations on the active principles of *Karaj* seeds — DR. M. O. FAROOQ, Aligarh University, Aligarh (1944-48).
 87. Electrical properties of alloys in the liquid state — PROF. K. S. KRISHNAN, Allahabad University, Allahabad (1944-48).
 88. Investigations on electrical properties of some typical order-disorder alloys — PROF. K. S. KRISHNAN, Allahabad University, Allahabad (1944-48).
 89. Production and testing of aluminium-titanium alloys — DR. DAYA SWARUP & PROF. V. G. IYER, Banaras Hindu University, Banaras (1944-47).

90. Production of metallic sodium and magnesium — DR. J. C. GHOSH, DR. A. N. RAO, DR. SANJIVA RAO, DR. M. R. A. RAO & MR. N. RAMCHANDRA RAO, Indian Institute of Science, Bangalore (1944-48).
91. Manufacture of beryllium alloys — DR. MATA PRASAD & MR. G. C. MITTER, Royal Institute of Science, Bombay (1944-47).
— DR. J. C. GHOSH & DR. S. K. NANDI, Indian Institute of Science, Bangalore (1947-50).
92. Directional finding of atmospherics — PROF. S. P. CHAKRAVARTI, Indian Institute of Science, Bangalore (1944-47).
93. Preparation of novocaine — PROF. P. C. GUHA, Indian Institute of Science, Bangalore (1944-48).
94. Penicillin and other antibiotics — PROF. V. SUBRAHMANYAN, Indian Institute of Science, Bangalore (1944-49).
95. Conditions favouring the increase of alcohol concentration in distillery washes — MR. M. SREENIVASAYA, Indian Institute of Science, Bangalore (1944-51).
96. Preparation of alkali and water soluble ethyl cellulose — DR. C. S. PATEL, Technological Laboratory, Baroda (1944-48).
97. Determination of the constitution of some commercial dyes — DR. K. VENKATARAMAN, Bombay University, Bombay (1944-50).
98. Economic utilization of turpentine oil for the manufacture of terpineol — DR. R. D. DESAI & DR. P. N. JOSHI, Bombay University, Bombay (1944-45).
99. Analysis and classification of metal scrap available in India — MR. G. C. MITTER, Government of India Mint, Bombay (1944-46).
100. Porcelain containers for hydrogen peroxide — Director of Industries, Government of Bombay (1944-45).
101. Rose Cultivation — DR. K. BISWAS, Botanical Garden, Calcutta (1944-48; 1951-53).
102. Measurement of Geological Time in India — PROF. M. N. SAHA, Calcutta University, Calcutta (1944-47).
103. Development of air driven ultra-centrifuge — PROF. K. ROY, Calcutta University, Calcutta (1944-49).
104. Design of moving iron ammeters and voltmeters of commercial grades — PROF. P. C. MAHANTI, Calcutta University, Calcutta (1944-49).
105. Study of polar crystals dissolved in glass systems — DR. S. K. MAJUMDAR, Presidency College, Calcutta (1944-48).
106. Investigations on steroids — MR. M. C. NATH, Dacca University, Dacca (1944-47).
107. Directional measurements of atmospherics — DR. S. R. KHASTGIR, Dacca University, Dacca (1944-47).
108. Briquetting of coals — DR. M. QURESHI, Osmania University, Hyderabad (Dn.) (1944-46).
109. Essential oils from bitter oranges — DR. B. K. MALVIYA, Lucknow University, Lucknow (1944-48).
110. Manufacture of sorbose — DR. M. DAMODARAN, Madras University, Madras (1944-48).
111. Essential oils of C.P. and Berar — DR. S. A. SALETORÉ, Laxminarayan Institute of Technology, Nagpur (1944-47).

112. Directional finding of atmospherics — Deputy Director General of Observatories, Poona (1944-47).
113. Directional finding of atmospherics — PROF. BHAGAVANTAM, Andhra University, Waltair (1944-47).
114. Thermionic functions of metals and alloys — PROF. K. S. KRISHNAN, Allahabad University, Allahabad (1945-48).
115. Manufacture of chemical porcelain — PROF. H. N. ROY, Banaras Hindu University, Banaras (1945-50).
116. Manufacture of better class saggars — PROF. H. N. ROY, Banaras Hindu University, Banaras (1945-50).
117. Production of synthetic methanol; production of formaldehyde from carbon monoxide and hydrogen — DR. J. C. GHOSH & DR. S. K. NANDI, Indian Institute of Science, Bangalore (1945-50).
118. Aromatic chemicals — PROF. P. C. GUHA, Indian Institute of Science, Bangalore (1945-48).
119. Utilization of essential oils as disinfectants — PROF. V. SUBRAHMANYAN, Indian Institute of Science, Bangalore (1945-48).
120. Cosmic rays — PROF. H. J. BHABHA, Tata Institute of Fundamental Research, Bombay (1945-47).
121. Setting up of a medium voltage positive ray discharge tube for the investigation of nuclear disintegration — DR. D. M. BOSE, Bose Research Institute, Calcutta (1945-48).
122. Research on cosmic rays — MR. P. C. BHATTACHARYA, Calcutta University, Calcutta (1945-48).
123. Jasmine — DR. S. N. BAL, Indian Museum, Calcutta (1945-47).
124. Manufacture of permanent magnets suitable for electrical instruments — MR. B. B. BHOWMIK, Randon House, Kalighat (1945-48).
125. Manufacture of diamond tools — DR. P. K. KICHLU, Punjab University, Lahore; Delhi University, Delhi (1945-50).
126. Manufacture of flash lamps — DR. P. K. KICHLU, Punjab University, Lahore (1945-47).
127. Carbohydrate metabolism in organisms with special reference to oxalic acid formation — DR. M. DAMODARAN, Madras University, Madras (1945-48).
128. Proteins and proteases — DR. M. DAMODARAN, Madras University, Madras (1945-48).
129. Manufacture of photographic developers — DR. B. B. DEY, Presidency College, Madras (1945-47).
130. Reconditioning of lead acid batteries — MR. V. V. L. RAO & MR. JOGA RAO, Provincial Broadcasting Department, Madras (1945-49).
131. Salvaging of electrolytic condensers — MR. V. V. L. RAO & MR. JOGA RAO, Provincial Broadcasting Department, Madras (1945-49).
132. Manufacture of Seger cones — PROF. H. N. ROY, Banaras Hindu University, Banaras (1946-50).
133. Electric furnace treatment of coal rich in sulphur — DR. J. C. GHOSH & DR. B. SANJIVA RAO, Indian Institute of Science, Bangalore (1946-49).
134. Production of phenol by the benzene sulphonic acid process — PROF. P. C. GUHA, Indian Institute of Science, Bangalore (1946-49).

135. Preparation of formaldehyde from power alcohol — DR. S. K. K. JATKAR, Indian Institute of Science, Bangalore (1946-49).
136. Dielectric constants — DR. S. K. K. JATKAR, Indian Institute of Science, Bangalore (1946-49).
137. Preparation of predigested and concentrated food products from edible seed cakes — PROF. V. SUBRAHMANYAN, Indian Institute of Science, Bangalore (1946-49).
138. Vegetable milks from oil seeds and related materials — PROF. V. SUBRAHMANYAN, Indian Institute of Science, Bangalore (1946-49).
139. Cytogenetics of yeasts and fungi — MR. SREENIVASAYA (later DR. M. K. SUBRAHMANYAM), Indian Institute of Science, Bangalore (1946-52).
140. Fatigue in metals and alloys — PROF. FRANK ADCOCK, Indian Institute of Science, Bangalore (1946).
141. Spectroscopy of fuels and their combustion — DR. N. R. TAWDE, Institute of Science, Bombay (1946-50).
142. Manufacture of high purity salt — DR. MATA PRASAD, Institute of Science, Bombay (1946-48).
143. High altitude measurement of the penetration component of cosmic radiation and ground experiments on mesons — PROF. H. J. BHABHA, Tata Institute of Fundamental Research, Bombay (1946-48).
144. Establishment of a betatron high energy accelerator — PROF. H. J. BHABHA, Tata Institute of Fundamental Research, Bombay (1946-47).
145. Leather research — MR. B. M. DAS, Bengal Tanning Institute, Calcutta (1946-49).
146. Preparation of optically active and racemic forms of compounds (pharmacological part) — DR. B. MUKERJI, Biochemical Standardization Laboratory, Calcutta (1946-48).
147. Investigations on transuranic elements — DR. D. M. BOSE, Bose Research Institute, Calcutta (1946-47).
148. Development of a new technique of investigation of the ionosphere — MR. B. M. BANERJEE, Calcutta University, Calcutta (1946-51).
149. Fermentative production of butyl alcohol, acetone and acids generally from molasses — DR. B. C. GUHA, Calcutta University, Calcutta (1946-48).
150. X-ray studies of metals and alloys — MR. K. BANERJI, Indian Association for the Cultivation of Science, Calcutta (1946-49).
151. Mechanism of production of mesons with the help of Wilson Cloud Chamber — DR. R. L. SEN GUPTA, Presidency College, Calcutta (1946-47).
152. Survey of aromatic plants of India — DR. S. KRISHNA, Forest Research Institute, Dehra Dun (1946-48).
153. Grain size control of ferrous and non-ferrous materials — Controller of Inspection (Metallurgical), Jamshedpur (1946-49).
154. Classification and cataloguing of technical literature relating to metals — Metals Research Committee (1946-48).
155. Photochemistry of ozone — DR. P. K. KICHLU, Punjab University, Lahore (1946-47).

156. Preparation of optically active and racemic forms of compounds suitable as medicinal substances — DR. B. K. SINGH, Punjab University, Lahore (1946-47).
157. Correlation of cosmic ray intensity with atmospheric variables — DR. P. S. GILL, Punjab University, Lahore (1946-47).
158. Utilization of bauxite deposits of C.P. — DR. S. A. SALETORÉ, Laxminarayan Institute of Technology, Nagpur (1946-49).
159. Atmospheric ozone and radiation equilibrium in atmosphere — DR. K. R. RAMANATHAN, Meteorological Department, Poona (1946-51).
160. Infra-red radiation from the atmosphere and solar radiation — DR. L. A. RAMDAS, Meteorological Department, Poona (1946-).
161. Scheme on *Sahar farsee* — DR. M. O. FAROOQ, Aligarh University, Aligarh (1947-49).
162. Isolation of the gelatinizing principles of *Bemisal Bel* — DR. M. A. AZIZ, Aligarh University, Aligarh (1947-49).
163. Manufacture and utilization of rosin — DR. N. R. DHAR, Allahabad University, Allahabad (1947-49).
164. Measurement of absorption coefficient of sound waves in air and other polyatomic gases — DR. R. N. GHOSH, Allahabad University, Allahabad (1947-50).
165. Chemical effects of X-ray emission and absorption spectra — DR. G. B. DEODHAR, Allahabad University, Allahabad (1947-52).
166. Industrial catalysts — DR. J. C. GHOSH & DR. S. K. NANDI, Indian Institute of Science, Bangalore (1947-50).
167. Manufacture of coumarin — PROF. P. C. GUHA, Indian Institute of Science, Bangalore (1947-49).
168. Ultrasonic velocity in gases and vapours — DR. S. K. K. JATKAR, Indian Institute of Science, Bangalore (1947-50).
169. Industrial catalysts — PROF. S. K. NANDI, Indian Institute of Science, Bangalore (1947-50).
170. Manufacture of phenol from chlorobenzene — DR. G. P. KANE, Bombay University, Bombay (1947-49).
171. Electrolytic oxidation of potassium manganate — MR. G. C. MITTER, Government of India Mint, Bombay (1947-50).
172. Antibiotic research centre — COL. S. S. BHATNAGAR, St. Xavier's College, Bombay (1947-).
173. Preparation of 8-aminoquinolines as possible antimalarials — DR. U. P. BASU, Bengal Immunity Research Institute, Calcutta (1947-53).
174. Compilation of a brochure on the indigenous drugs of India — DR. B. MUKERJI, Biochemical Standardization Laboratory, Calcutta; DR. S. SIDDIQUI, Delhi Laboratories, Delhi and DR. B. MUKERJI, Central Drug Research Institute, Lucknow (1947-49).
175. Raman spectra and luminescence of organic compounds at low temperature — DR. S. C. SARKAR, Calcutta University, Calcutta (1947-49).
176. Chemical composition of Tipper's collection of rare earth minerals in India — DR. P. B. SARKAR, Calcutta University, Calcutta (1947-49).
177. X-ray investigations of coal — DR. K. BANERJI, Indian Association for the Cultivation of Science, Calcutta (1947-52).

178. Survey, cultivation and improvement of medicinal plants — COL. R. N. CHOPRA, Drug Research Laboratory, Jammu-Tawi (1947-53).
179. Investigations on the cultivation of *Ocimum* plants — Department of Agriculture, U.P., Kanpur (1947-48).
180. Atmospheric ozone and radiation balance in the atmosphere — DR. K. R. RAMANATHAN, Physical Research Laboratory, Ahmedabad (1948-51).
181. Manufacture of glucose from starchy tubers — DR. M. O. FAROOQ, Aligarh University, Aligarh (1948-49).
182. Study of piezoelectric, elastic, optical and twinning properties of crystalline quartz in relation to its crystal structure — DR. B. D. SAXENA, Allahabad University, Allahabad (1948-52).
183. Study of effect of light on the electrical conductivity of systems activated by various types of discharge — DR. S. S. JOSHI, Banaras Hindu University, Banaras (1948-52).
184. Investigation on bellary leaf oil — MR. S. G. SASTRY, Bangalore (1948-49).
185. Preparation of new antimalarials — PROF. P. C. GUHA, Indian Institute of Science, Bangalore (1948-).
186. Preparation of vinyl plastics from alcohol and chlorine — DR. S. K. K. JATKAR, Indian Institute of Science, Bangalore (1948-50).
187. Manufacture of acetic acid and acetic anhydride from ethyl alcohol — PROF. B. SANJIVA RAO, Indian Institute of Science, Bangalore (1948-50).
188. Uranium, thorium and radium contents of Madras granites (physical part) — DR. R. S. KRISHNAN, Indian Institute of Science, Bangalore (1948-53).
189. Biological aspects of atomic research — DR. A. R. GOPAL IYENGAR, Tata Institute of Fundamental Research, Bombay (1948).
190. Electroplating of non-conducting surfaces — DR. B. N. GHOSH, Calcutta University, Calcutta (1948-51).
191. Investigation on theory and properties of meson field — DR. R. C. MAJUMDAR, Delhi University, Delhi (1948-49).
192. Investigations of micro-palaeobotanical problems — DR. A. O. HÖEG, Director, Birbal Sahni Institute of Palaeobotany, Lucknow (1948-53).
193. Preparation of alkyl sulphonilamides, phosphanilic acid and related substances — PROF. B. V. BHIDE, S. P. College, Poona (1948-50).
194. Uranium, thorium and radium contents of Madras granites (petrochemical part) — PROF. C. MAHADEVAN, Andhra University, Waltair (1948-53).
195. Pharmacological & Pharmacognostic Research Unit — DR. B. MUKERJI, Central Drugs Laboratories, Calcutta (1949-51).
196. Polarization of downcoming radio waves — DR. S. R. KHASTGIR, Banaras Hindu University, Banaras (1949-).
197. Elucidation of the constituents of essential oils — PROF. P. C. GUHA, Indian Institute of Science, Bangalore (1949-50).
198. Synthesis of citrinin and preparation of derivatives of citrinin — DR. K. VENKATARAMAN, Bombay University, Bombay (1949-52).
199. Synthetic tanstuffs from coal-tar distillation products — MR. B. M. DAS, Bengal Tanning Institute, Calcutta (1949-52).

200. Glazed kid manufacture — MR. B. M. DAS, Bengal Tanning Institute, Calcutta (1949-52).
201. Boxside and other industrial leathers — MR. B. M. DAS, Bengal Tanning Institute, Calcutta (1949-52).
202. Preparation of drugs containing coumarin and chromone nucleus — DR. D. CHAKRAVARTI, College of Engineering & Technology, Calcutta (1949-).
203. Construction of osmometers suitable for high polymer research — DR. S. R. PALIT, Indian Association for the Cultivation of Science, Calcutta (1949-).
204. Survey of fungus flora of India in search of antibiotics — DR. S. R. BOSE, R. G. Kar Medical College, Calcutta (1949-).
205. Anatomical study of cellulosic raw materials — DR. K. A. CHOWDHRY & DR. R. V. BHAT, Forest Research Institute, Dehra Dun (1949-).
206. Synthesis of new types of insecticides — DR. T. R. SESHADRI, Delhi University, Delhi (1949-).
207. Development of magnetic dust cores — DR. B. D. TOSHNIWAL, Meteorological Department, Poona (1949-).
208. Bactericidal and fungicidal properties of some selected plants — DR. G. S. PENDSE, Indian Drugs Research Association, Poona (1949-52).
209. Recording and analysis of reflections of electromagnetic waves from the ionosphere — DR. K. R. RAMANATHAN, Physical Research Laboratory, Ahmedabad (1950-).
210. Intensity variation of short wave radio signals and their bearing on the ionosphere — DR. S. S. BANERJI, Banaras Hindu University, Banaras (1950-52).
211. Absorption and emission spectra of toluene — DR. R. K. ASUNDI, Banaras Hindu University, Banaras (1950-).
212. Study of the nature of atmospherics — DR. S. R. KHASTGIR, Banaras Hindu University, Banaras (1950-).
213. Doppler effect in positive rays — DR. B. DASANNACHARYA, Banaras Hindu University, Banaras (1950-51).
214. Manufacture of α and β -ionone — Hindusthan Fine Chemicals Co., Bangalore (1950-51).
215. Manufacture of vanillin on pilot plant scale — Hindusthan Fine Chemicals Co., Bangalore (1950-51).
216. Production of aluminium metal by the electrolysis of molten anhydrous aluminium chloride — DR. E. G. RAMACHANDRAN, Indian Institute of Science, Bangalore (1950-).
217. Hot air engines and their development — PROF. H. A. HAVEMANN, Indian Institute of Science, Bangalore (1950-).
218. Crystal growth — DR. R. S. KRISHNAN, Indian Institute of Science, Bangalore (1950-53).
219. Anthraquinoid and sulphurized vat dyes — DR. K. VENKATARAMAN, Bombay University, Bombay (1950-).
220. Antibacterial and antifungal compounds from naphthalene — MR. M. L. KIDRANA, Bombay University, Bombay (1950-53).
221. Training in quality control — MR. N. R. S. SASTRY, Indian Statistical Institute, Bombay Branch, Bombay (1950-).

222. Mechanism of explosions — DR. N. R. TAWDE, Institute of Science, Bombay (1950-).
223. Development of gas turbines and jet propulsion units — DR. S. R. SEN GUPTA, Bengal Engineering College, Calcutta (1950-).
224. Gases in steel — DR. G. P. CHATTERJEE, Bengal Engineering College, Sibpur, Howrah (1950-).
225. Investigations on R.C.-coupled FM oscillator — DR. H. RAKSHIT, Bengal Engineering College, Sibpur, Howrah (1950-53).
226. Colloidal instability of cloud particles above and below freezing point — DR. S.K. BANERJEE, Jadavpur Engineering College, Calcutta (1950-53).
227. Preparation of cortisone and corticosterone analogues — DR. D. K. BANERJI, College of Engineering & Technology, Calcutta (1950-).
228. Investigation on Indian medicinal plants — DR. D. CHAKRAVARTI, College of Engineering & Technology, Calcutta (1950-52).
229. Production of nodular cast irons without employing standard malleabilizing cycles — MR. K. C. SOOD, Metals Processing Industries Ltd., Calcutta (1950-).
230. Development of heavy duty parts of internal combustion engines — PROF. A. VISWANATH, Government Engineering College, Coimbatore (1950-51).
231. Production of synthetic sapphires — DR. P. K. KICHLU, Delhi University, Delhi (1950-).
232. Synthesis of kellin, its isomers and related compounds — DR. T. R. SESHADRI, Delhi University, Delhi (1950-).
233. Chemical investigation of Indian lichens — DR. T. R. SESHADRI, Delhi University, Delhi (1950-).
234. Manufacture of alcohol from bagasse and other agricultural wastes (pilot plant investigation) — DR. N. R. KULLOOR, Shri Ram Institute for Scientific Research, Delhi (1950-52).
235. Preparation, testing and standardization of quartz oscillator plates — DR. S. BHAGVANTAM, Osmania University, Hyderabad (Dn.) (1950-52).
236. Production method and properties of low carbon alloy steels containing manganese — DR. SCHRADER, Tata Iron & Steel Co. Ltd., Jamshedpur (1950-).
237. Reaction kinetics of the vapour phase thermal decomposition of metal alkyls — DR. LOURDU M. YEDDANAPALLI, Loyola College, Madras (1950-53).
238. Electrolytic oxidation of organic aromatic compounds — DR. B. B. DEY, Presidency College, Madras (1950-53).
239. Studies in copper-rich portion of copper titanium system — PROF. G. K. OGALE, Engineering College, Poona (1950-53).
240. Design and development of certain electrical measuring instruments — MR. N. M. ATHAVALE, Laboratory Apparatus Works, Poona (1950-).
241. Travelling wave disturbances in the ionosphere — DR. B. RAMACHANDRA RAO, Andhra University, Waltair (1950-).
242. Atmospheric ozone and weather — DR. K. R. RAMANATHAN, Physical Research Laboratory, Ahmedabad (1951-).
243. Absorption of microwaves in the 3 cm. region — MR. KRISHNAJI, Allahabad University, Allahabad (1951-).

244. Halogenation of organic compounds under electric discharge — DR. S. S. JOSHI, Banaras Hindu University, Banaras (1951-).
245. Pilot plant experiments on modified aluminothermic reduction of titanium and similar metals — DR. DAYA SWARUP & DR. S. RAMAMURTHY, Banaras Hindu University, Banaras (1951-).
246. Preparation and properties of high purity titanium metal — DR. DAYA SWARUP & DR. S. RAMAMURTHY, Banaras Hindu University, Banaras (1951-).
247. Selective excitation of atomic and molecular spectra — DR. R. K. ASUNDI, Banaras Hindu University, Banaras (1951-).
248. Development of continuous fermentation process — MR. M. SREENIVASAYA, Indian Institute of Science, Bangalore (1951-52).
249. Sulphur producing bacteria as sources of elemental sulphur — MR. M. SREENIVASAYA, Indian Institute of Science, Bangalore (1951-52).
250. Electropolishing of bearing surfaces — DR. BRAHM PRAKASH, Indian Institute of Science, Bangalore (1951-53).
251. Cultural experiments on *Patchouli* — MR. B. S. NIRODY, Indian Institute of Science, Bangalore (1951-).
252. Modification of Mowrah fat — DR. J. G. KANE, Bombay University, Bombay (1951-).
253. Research on chloramphenicol (chloromycetin) analogues and derivatives — DR. B. D. TILAK, Bombay University, Bombay (1951-).
254. Research on electro-refining and recovery of copper from copper scrap — MR. G. C. MITTER, Government of India Mint, Bombay (1951-).
255. Nutritive value of canned foodstuffs in India — DR. N. G. MAGAR, Institute of Science, Bombay (1951-).
256. Corrosion of metals and alloys with special reference to the effect of titanium — DR. G. P. CHATTERJEE & DR. B. CHATTERJEE, Bengal Engineering College, Calcutta (1951-).
257. Binary and ternary alloy systems with titanium as one of the alloying constituents — DR. G. P. CHATTERJEE and DR. B. CHATTERJEE, Bengal Engineering College, Calcutta (1951-).
258. Microseisms and seawaves, and their correlation with cyclonic disturbances — DR. S. K. CHAKRAVARTY, Bengal Engineering College, Calcutta (1951-).
259. Development of flash steam generator — MR. R. K. MUKHERJEE, Bengal Engineering College, Calcutta (1951-).
260. Biological studies on malarial parasites — DR. U. P. BASU, Bengal Immunity Research Institute, Calcutta (1951-).
261. Studies in the physico-chemical properties of hides, tanned and untanned — DR. B. N. GHOSH, Calcutta University, Calcutta (1951-).
262. Determination of processing conditions for the preservation of Indian vegetables — DR. A. N. BOSE, College of Engineering & Technology, Calcutta (1951-).
263. Construction of light scattering apparatus for the measurement of molecular weight, size and shape of high polymers — DR. S. R. PALIT, Indian Association for the Cultivation of Science, Calcutta (1951-).
264. Minerographic study of polished sections of opaque ore minerals — PROF. N. N. CHATTERJEE, Presidency College, Calcutta (Nov. 1951-March 1953; Sept. 1953-).

265. Chemical and pharmacological investigations on some reputed cardiac and uterine drugs of indigenous *Materia Medica* — DR. B. N. GHOSH, R. G. Kar Medical College, Calcutta (1951-).
266. Metabolic studies of human malaria parasites — DR. R. N. CHOWDHRY, Tropical School of Medicine, Calcutta (1951-).
267. Screening of antimalarial drugs — COL. JASWANT SINGH, Malaria Institute of India, Delhi (1951-).
268. Biological assay of insecticides — COL. JASWANT SINGH, Malaria Institute of India, Delhi (1951-).
269. Pilot plant investigation on briquetting of non-caking Indian coals — Director, Central Laboratories for Scientific & Industrial Research, Hyderabad (Dn.) (1951-).
270. Investigation into the preparation of briquettes for charging in low shaft furnace — DR. D. JAGAT RAM, Tata Iron & Steel Co. Ltd., Jamshedpur (1951-).
271. Palaeobotanical investigation of Indian coals — Director, Birbal Sahni Institute of Palaeobotany, Lucknow (1951-).
272. Bacteriostatic action of drugs — DR. S. P. GUPTA, K. G. Medical College, Lucknow (1951-52).
273. Thyroid activity of thyoglobulin and other iodoproteins with reference to chemical composition — DR. P. S. SARMA, Madras University, Madras (1951-).
274. Scattering of radio waves — DR. S. S. BANERJI, Banaras Hindu University, Banaras (1952-).
275. Development of heavy duty parts of internal combustion engines — PROF. H. A. HAVEMANN, PROF. M. S. THACKER, DR. A. RAMACHANDRAN & MR. M. R. K. RAO, Indian Institute of Science, Bangalore (1952-).
276. Design and development of an air-cooled aero otto engine — PROF. H. A. HAVEMANN, DR. V. M. GHATAGE & MR. R. G. NARAYANAMURTHY, Indian Institute of Science, Bangalore (1952-).
277. Investigation of aluminium coating of steel — DR. BRAHM PRAKASH, Indian Institute of Science, Bangalore (1952-).
278. Special studies of heterocyclic aromatic compounds — DR. M. R. RADHYE, Bombay University, Bombay (1952-53).
279. Microbiological research centre — COL. S. S. BHATNAGAR, St. Xavier's College, Bombay (1952).
280. Investigation and study of the characteristics of Sunderbans mangrove, especially *goran* — MR. M. BANERJEE, Bengal Tanning Institute, Calcutta (1952-).
281. Manufacture of upholstery and other special types of leather — MR. M. BANERJEE, Bengal Tanning Institute, Calcutta (1952-).
282. Microscopical data and standard specification for VT sole leather — MR. M. BANERJEE, Bengal Tanning Institute, Calcutta (1952-).
283. Studies on thermodynamic properties of high polymer solutions — DR. S. R. PALIT, Indian Association for the Cultivation of Science, Calcutta (1952-).
284. Flora of Delhi State — PROF. P. MAHESHWARI, Delhi University, DELHI (1952-).

285. Pilot plant for the manufacture of ether and ethylene dichloride from alcohol — DR. D. N. DARUVALLA, Shri Ram Institute for Industrial Research, Delhi (1952-).
286. Survey of medicinal and economic plants of Ladakh — COL. R. N. CHOPRA, Drug Research Laboratory, Jammu-Tawi (1952-).
287. Cultivation of medicinal plants — PROF. K. N. KAUL, Sikusubagh, Lucknow (1952-53).
288. Polyvaccine for typhoid, cholera and dysentery — DR. S. P. GUPTA, K. G. Medical College, Lucknow (1952-).
289. Indian cardiac drugs — PROF. S. RANGASWAMI, Andhra University, Waltair (1952-53).
290. Study of X-ray emission and absorption spectra in the region 1.8-10 Å — DR. G. B. DEODHAR, Allahabad University, Allahabad (1953-).
291. X-ray diffraction studies in crystals — PROF. K. BANERJEE, Allahabad University, Allahabad (1953-).
292. Uses of photo-multiplier tubes in the measurement of feeble X-ray intensity — PROF. K. BANERJEE, Allahabad University, Allahabad (1953-).
293. Investigation of spectra of molecules in the ultraviolet region — DR. K. MAJUMDAR, Allahabad University, Allahabad (1953-).
294. Investigation on the critical conditions of producing plaster of Paris suitable for making moulds for potteries from gypsum available in the country — PROF. H. R. ROY, Banaras Hindu University, Banaras (1953-).
295. Critical examination of nepheline seyanite available in India — DR. R. CHARAN, Banaras Hindu University, Banaras (1953-).
296. Studies of the refractory and ceramic properties of Indian pyrophyllite — DR. M. L. MISRA, Banaras Hindu University, Banaras (1953-).
297. Studies in stereochemistry — DR. BAWA KARTAR SINGH, Banaras Hindu University, Banaras (1953-).
298. Age determination of certain igneous and metamorphic rocks of pre-Cambrian era — DR. R. S. KRISHNAN, Indian Institute of Science, Bangalore (1953-).
299. Design and construction of ionospheric recorder — PROF. K. SRINIVASAN, Indian Institute of Science, Bangalore (1953-).
300. Investigation on microwave propagation — PROF. K. SRINIVASAN, Indian Institute of Science, Bangalore (1953-).
301. Recovery of sulphur as hydrogen sulphide from sulphates — DR. G. P. KANE, Bombay University, Bombay (1953-).
302. Economic utilization of tamarind seed — DR. A. N. PURI, Field Research Station, Bombay (1953-).
303. Sulphur analogues of polycyclic hydrocarbons and sterols for their carcinogenic and cancer inhibiting properties — DR. V. R. KHANOLKAR, Indian Cancer Research Centre, Bombay (1953-).
304. Electro-diffraction studies of semi-conductor rectifiers and development of copper oxide triode — PROF. K. R. DIXIT, Institute of Science, Bombay (1953-).
305. Trypsin inhibitors in Indian foodstuffs — DR. (MRS.) K. SOHONIE, Institute of Science, Bombay (1953-).
306. Nutritive value of palm *gar* — DR. (MRS.) K. SOHONIE, Institute of Science, Bombay (1953-).

307. Stability of component fatty acids in hydrogenated fats — DR. N. G. MAGAR, Institute of Science, Bombay (1953-).
308. New paths to chloramphenicol (chloromycetin) — DR. A. TYABJI, Institute of Science, Bombay. (1953-).
309. Studies on the production of an antibiotic substance by *Streptomyces* spp.—DR. P. N. NANDI, Bose Research Institute, Calcutta (1953-).
310. Investigations of lunar and solar tides in the ionosphere — MR. B. M. BANERJEE, Calcutta University, Calcutta (1953-).
311. Electrochemical properties of resin systems in relation to reactions involving exchange of ions — DR. B. N. GHOSH, Calcutta University, Calcutta (1953-).
312. Microbial production of vitamin B₁₂ — DR. S. C. ROY, Calcutta University, Calcutta (1953-).
313. Studies on antifungal antibiotics — DR. S. K. BOSE, Calcutta University, Calcutta (1953-).
314. Drawing up of a uniform calendar for India — PROF. M. N. SAHA, Chairman, Calendar Reform Committee (1953-).
315. Finding a rich source of stigmaterol and its isolation—DR. R. N. CHAKRAVARTI, Tropical School of Medicine, Calcutta (1953-).
316. Protection of timber against attack of marine organisms — President, Forest Research Institute, Dehra Dun (1953-).
317. Ruling engine for diffraction gratings — DR. P. K. KICHLU, Delhi University, Delhi (1953-).
318. Systematic survey of coalfields of Hyderabad State — Director, Central Laboratories, Hyderabad (Dn.) (1953-).
319. X-ray studies of Indian clays (kaolin group) — DR. SULTANA Z. ALI, Central Laboratories for Scientific & Industrial Research, Hyderabad (Dn.) (1953-).
320. Fat production by microbial farming — DR. H. N. DE, M. G. M. Medical College, Indore (1953-).
321. Cultivation and commercial development of medicinal and economic plants (insecticidal and insect repellent group) of N.-W. Himalayan region — COL. R. N. CHOPRA, Drug Research Laboratory, Jammu-Tawi (1953-).
322. Palynology — Director, Birbal Sahni Institute of Palaeobotany, Lucknow (1953-).
323. Thermal diffusion and inter-diffusion of gases — DR. B. N. SRIVASTAVA, Lucknow University, Lucknow (1953-).
324. Age determination of certain igneous and metamorphic rocks of pre-Cambrian era — PROF. C. MAHADEVAN, Andhra University, Waltair (1953-).
325. Fluorescence and absorption spectra of organic molecules — DR. V. RAMAKRISHNA RAO, Andhra University, Waltair (1953-).
326. Development of microwave technique and its applications — DR. K. RANGADHAMA RAO, Andhra University, Waltair (1953-).
327. Palaeobotanical investigations in relation to the measurement of geological age of rocks — Director, Birbal Sahni Institute of Palaeobotany, Lucknow (1953-).
328. Study of absorption and dielectric properties in the microwave region—DR. P. N. SHARMA, Lucknow University, Lucknow (1953-).

(b) RESEARCH SCHEMES IN CSIR LABORATORIES

1. Manufacture of synthetic wool — DR. S. S. BHATNAGAR (1940-46).
2. Manufacture of ammonium phosphate — DR. S. S. BHATNAGAR (1940-43).
3. *Serpentina* alkaloids, *kurchi* alkaloids, industrial uses of bhilawan resins and substitutes of agar agar and mannite — DR. S. SIDDIQUI (1940-50).
4. Carbon electrodes for arc purposes — DR. LAL C. VERMAN (1940-49).
5. Extraction of sulphur compounds from coal — DR. LAL C. VERMAN (1940-46).
6. Manufacture of ammonium nitrate — DR. S. S. BHATNAGAR & MR. PRAKASH NARAIN (1942-43).
7. Titanium dioxide from bauxite sludge — DR. S. PARTHASARATHY (1942-45).
8. Investigations on *neem* — DR. S. SIDDIQUI (1942-50).
9. Manufacture of magnesium from magnesite — DR. S. PARTHASARATHY (1942-45).
10. Portable producer gas plant — DR. LAL C. VERMAN (1942-50).
11. Manufacture of resistance alloys — DR. S. PARTHASARATHY (1942-44).
12. Manufacture of ebonite substitutes and allied products — DR. S. SIDDIQUI (1943-50).
13. Production of plastics from seed cakes and coffee leaves — DR. S. S. BHATNAGAR (1943).
14. Pyrethrum and pyrethrum substitutes — DR. S. SIDDIQUI (1944-50).
15. Antimalarial drugs — DR. S. SIDDIQUI (1944-50).
16. Semi-synthetic tanning materials — DR. S. SIDDIQUI (1944-50).
17. Industrial utilization of resins from the latex of *Euphorbiaceae* — DR. S. S. BHATNAGAR & DR. KARIMULLAH (1944-48).
18. Extraction of rubber from *Cryptostegia grandiflora* — DR. S. S. BHATNAGAR & DR. KARIMULLAH (1944-46).
19. Preparation of vitamin B₁, Beemax and Marmite — DR. BASHIR AHMAD (1944-47).
20. Polyhydric alcohols from sugar — DR. KARIMULLAH (1944-47).
21. Manufacture of sorbose — DR. M. DAMODARAN, University of Madras (1945-48); NCL, Poona (1948-50).
22. Carbohydrate metabolism — DR. M. DAMODARAN, University of Madras (1945-48); NCL, Poona (1948-50).
23. Proteins and proteases — DR. M. DAMODARAN, University of Madras (1945-48); NCL, Poona (1948-50).
24. Technical applications of ultrasonics — DR. S. PARTHASARATHY (1946-47).
25. Powder metallurgy — DR. LAL C. VERMAN (1946-49).
26. Investigations of *kutra singi*, *brahmi* and *brahmi manduki* — DR. KARIMULLAH (1946-47).
27. Testing of samples of earth, alloys and broken machinery brought from Hiroshima — DR. S. PARTHASARATHY (1946).

28. Survey of biological products as raw materials — DR. M. DAMODARAN, NCL, Poona (1947-50).
29. Building Research Unit — Building Research Committee (1947-51).
30. Better glass segers — CGCRI, Calcutta (1947-50).
31. Tobacco seed oil — DR. J. S. AGGARWAL, NCL, Poona (1947-50).
32. Study of surface active higher alkyl ammonium cations as antibacterials — DR. M. DAMODARAN, NCL, Poona (1948-50).
33. Postal stationery ink — DR. S. SIDDIQUI (1948-50).
34. Manufacture of optical glass — CGCRI, Calcutta (1948-50).
35. Plastics in general — DR. LAL C. VERMAN (1949-50).
36. Predigested concentrated food products from seed cakes — CFTRI, Mysore (1949-50).
37. Vegetable milk — CFTRI, Mysore (1949-50).
38. Beryllium alloys — NML, Jamshedpur (1949-50).
39. Low temperature carbonization of coal — FRI, Jealgora (1949-50).
40. Microbiological methods for the assay of complex organic substances — DR. M. DAMODARAN, NCL, Poona (1950).
41. Manufacture of glucose oxidase — DR. M. DAMODARAN, NCL, Poona (1950).
42. Survey of aromatic plants (*citrus*) — CFTRI, Mysore (1950-52).
43. Ink manufacturing scheme — NPL, New Delhi (1952-).
44. Compilation of a Directory of Type Culture Collections in India — NCL, Poona (1952).
45. Utilization and processing of cotton seed oil for edible purposes — CFTRI, Mysore (1952-)
46. Preparation of research chemicals — NCL, Poona (1952-).
47. Literature survey of oils and fats — CFTRI, Mysore (1949-).
48. Electropolishing of bearing surfaces in relation to ferrous and other alloys used in mechanical engineering, CECRI, Karaikudi (1953-).

(c) BLOCK GRANTS

1. The Tata Institute of Fundamental Research, Bombay (1945-).
2. Establishment of a Chair in Dyestuffs Technology — Department of Chemical Technology, University of Bombay, Bombay (1946-).
3. The Institute of Leather Research, Madras University, Madras (1946-47).
4. The Institute of Nuclear Physics, Calcutta (1946-47).
5. Scientific investigation of minerals of India — PROF. C. V. RAMAN, Bangalore (1947-48).
6. Compilation of data about scientific personnel in India — DR. D. S. KOTHARI, Delhi (1947-50).
7. Training in quality control — The Indian Statistical Institute, Bombay (1950-).
8. The Yogic Institute, Lonavla, Bombay (1951).

9. The Institution of Engineers, Central India Centre, New Delhi (1951).
10. Cultivation of medicinal plants — Govt. Agricultural College, Kanpur (1952).
11. Chittaranjan Cancer Hospital, Calcutta (1953).

APPENDIX III

CSIR PATENTS INCLUDING PENDING APPLICATIONS

1940

- 27714:** *Process for improving the mechanical and physical properties of wood* — S. S. BHATNAGAR, L. C. VERMAN, S. M. KARIM & G. D. JOGLEKAR (Calcutta Lab.)
- 27715:** *Improved process for the production of lubricating oils* — J. S. AGGARWAL, H. D. CHOWDHURY, S. N. MUKERJI & L. C. VERMAN (Calcutta Lab.)

1941

- 28002-3:** *A process for the conversion of bhilawan shell liquid to a non-vesicating drying product for the manufacture of lacquer varnishes, stoving enamels, water-proofing, electric insulating and plastic compositions or like materials* — S. SIDDIQUI & S. K. RANGANATHAN (Calcutta Lab.)
- 28004-5:** *A process for the conversion of bhilawan shell liquid to a non-vesicating drying product for the manufacture of lacquer varnishes, stoving enamels, water proofing, electric insulating and plastic compositions or like materials* — S. SIDDIQUI & A. KHAN (Calcutta Lab.)
- 28135:** *A process for the preparation of a depolarizing agent for dry cells* — K. SUBBARAMAIAH & L. C. VERMAN (Calcutta Lab.)
- 28277:** *Improvements in or relating to laminated boards* — S. S. BHATNAGAR, C. A. R. KHAN & L. C. VERMAN (Calcutta Lab.)
- 28281:** *Improvements in or relating to laminated corrugated boards* — S. S. BHATNAGAR, C. A. R. KHAN & L. C. VERMAN (Calcutta Lab.)
- 28306:** *Improvements in plastic compositions* — S. S. BHATNAGAR & A. AHMAD (Calcutta Lab.)
- 28307:** *A method of preparing a rubber composition for manufacturing artificial cork, stoppers, refrigerator pads, insulating materials and like substances, and the substances so manufactured* — S. S. BHATNAGAR & A. AHMAD (Calcutta Lab.)
- 28376:** *Improvements in or relating to the degradation of proteinous materials* — A. RAM, S. S. BHATNAGAR & KARIMULLAH (Calcutta Lab.)
- 28424:** *Process for the conversion of cashew nut shell liquid to a drying product for the manufacture of lacquer varnishes, stoving enamels, water-proofing, electric insulating and plastic compositions, and like materials* — S. SIDDIQUI & A. A. KHAN (Calcutta Lab.)

- 28427: *Improvements in or relating to containers, receptacles, utensils and the like* — S. S. BHATNAGAR, P. PRAKASH & L. C. VERMAN (Calcutta Lab.)
- 28428: *A process for obtaining resin from agricultural wastes such as bagasse and jute wastes, and the resin so obtained* — S. S. BHATNAGAR, P. NARAIN & G. S. TEWARI (Calcutta Lab.)
- 28563: *A process for the transformation of castor oil gel into a soluble viscous liquid* — S. K. RANGANATHAN & S. SIDDIQUI (Calcutta Lab.)

1942

- 28974: *Improvements in or relating to the degradation of proteinous materials* — A. RAM, S. S. BHATNAGAR & KARIMULLAH (Delhi Lab.)
- 28990: *Duplicating ink and a process for its preparation* — MISS S. RAM (New Delhi)
- 29051: *Modification of a process for the conversion of bhilawan shell liquid to a non-vesicating drying product for the manufacture of lacquer varnishes, stoving enamels, water-proofing, electric insulating and plastic compositions, or like materials* — S. SIDDIQUI & A. A. KHAN (Delhi Lab.)
- 29128: *A collapsible tube or the like container and a method of making the same* — S. S. BHATNAGAR & P. PRAKASH (Delhi Lab.)
- 29155: *A process for the reclamation of rubber waste for producing substitutes of hard and soft rubber, vulcanite, ebonite, and composite moulding powders, adhesives, impregnating solutions and like products* — S. SIDDIQUI & A. A. KHAN (Delhi Lab.)

1943

- 29374: *Process and plant for the manufacture of phthalic anhydride* — S. S. BHATNAGAR, N. GHATAK & KARIMULLAH (Delhi Lab.)
- 29400: *Padding material from coconut coir* — A. AHMAD, D. A. BASIR, S. BHATIA & S. S. BHATNAGAR (Delhi Lab.)
- 29412: *Improvements in or relating to fluids used in hydraulic mechanism* — J. S. AGGARWAL, S. S. BHATNAGAR & L. C. VERMAN (Delhi Lab.)
- 29842: *Water detecting composition* — A. RAM, V. LEZARD & M. R. VERMA (Delhi Lab.)
- 29938: *A process for the conversion of bhilawan shell liquid to a nonvesicating drying product for the manufacture of lacquer varnishes, stoving enamels, water-proofing, electric insulating and plastic compositions or like materials* — S. SIDDIQUI & A. A. KHAN (Delhi Lab.)
- 29939: *Improvements in or relating to rendering textile fabric non-inflammable and water resistant* — A. RAM, S. S. BHATNAGAR, KARIMULLAH & C. A. R. KHAN (Delhi Lab.)
- 29940: *Improvements in or relating to rendering textile fabric non-inflammable and water resistant* — A. RAM, S. S. BHATNAGAR, KARIMULLAH & C. A. R. KHAN (Delhi Lab.)

- 29966: *Preparation of resinous materials from the milky juice of plant Euphorbia tirucalli* — A. RAM, S. S. BHATNAGAR, N. L. DUTTA, KARIMULLAH & G. C. SMITH (Delhi Lab.)
- 29967: *A process and apparatus for the production of ammonium carbonate* — J. C. GHOSH & B. S. KULKARNI (Indian Inst. Sci.)
- 29968: *Water-proof and gas-proof fabrics from castor oil products* — M. QURESHI & T. V. SUBBA RAO (Indian Inst. Sci.)
- 29969: *An apparatus for the production of urea* — J. C. GHOSH & B. S. KULKARNI (Indian Inst. Sci.)
- 30072: *An ice bag or like container and a method of making the same* — S. S. BHATNAGAR & P. PRAKASH (Delhi Lab.)
- 30196: *A method of and composition for lining and seaming containers* — S. S. BHATNAGAR, KARIMULLAH & G. S. TEWARI (Delhi Lab.)
- 30316: *Cold moulding composition for the manufacture of moisture resistant or insulating articles such as boards, switches, bottle-caps, trays, panels for radio receiving sets or the like* — M. QURESHI & M. A. R. KHAN (Osmania Univ.)

1944

- 30451: *A process for the manufacture of sintered glassware* — B. V. J. RAO (Delhi Lab.)
- 30502: *An improved process of the degradation of keratinous materials or the like* — S. S. BHATNAGAR, A. JOGARAO & L. C. VERMAN (Delhi Lab.)
- 30503: *An improved pencil eraser* — M. QURESHI & M. A. R. KHAN (Osmania Univ.)
- 30679: *Improvements in or relating to the production of foam generating substances* — S. S. BHATNAGAR, A. RAM, A. JOGARAO, KARIMULLAH & L. C. VERMAN (Delhi Lab.)
- 30680 (Filed U.S.A.; sealed U.K.): *Improvements in or relating to the manufacture of containers, receptacles, hollow-ware or the like from resin impregnated laminations* — S. S. BHATNAGAR, A. R. KHAN & L. C. VERMAN (Delhi Lab.)
- 31282: *Improvements in or relating to the manufacture of moulding powders* — S. S. BHATNAGAR, A. JOGARAO & L. C. VERMAN (Delhi Lab.)
- 31283: *A sealing composition and method for sealing holes in metallic or other sheets, containers or the like* — A. RAM, S. S. BHATNAGAR & M. R. VERMA (Delhi Lab.)
- 31284: *Varnish from castor oil products* — M. QURESHI & T. V. SUBBA RAO (Osmania Univ.)
- 31510: *Improvements in or relating to the grinding and utilization of mica* — R. C. RAY (Science College, Patna)
- 31511: *Improvements in or relating to the grinding and utilization of mica* — R. C. RAY (Science College, Patna)
- 31594: *Anthraquinone vat dyestuffs* — V. V. GOKHALE & K. VENKATARAMAN (Bombay Univ.)
- 31595: *Improvements in or relating to rendering paper water-proof grease-proof and non-porous* — KARIMULLAH & G. S. TEWARI (Delhi Lab.)

- 31877: *Improvements in or relating to the manufacture of flux compositions for aluminium or its alloys* — S. S. BHATNAGAR & A. L. S. RAO (Delhi Lab.)

1945

- 32237: *Improvements in or relating to the expulsion of the shell liquid from bhulan or cashew nuts* — S. SIDDIQUI & A. A. KHAN (Delhi Lab.)
- 32352: *Improvements in or relating to the extraction of rubber from Cryptotegia* — S. S. BHATNAGAR, KARIMULLAH & U. SHANKAR (Delhi Lab.)
- 32486: *Improvements in or relating to the manufacture of benzidine* — B. B. DEY, T. R. GOVINDACHARI & S. C. RAJAGOPALAN (Presidency College, Madras)
- 32823: *Improvements in or relating to the production of raised patterns or lettering on the surface of plastic moulded products* — B. N. SIKKA, G. SINGH & L. C. VERMAN (Delhi Lab.)
- 32824: (Sealed in U.S.A. & U.K.): *Improvements in or relating to the manufacture of containers hollow-wax or the like articles from resin impregnated laminations* — B. N. SIKKA, G. SINGH & L. C. VERMAN (Delhi Lab.)
- 32834: *Improvements in or relating to the manufacture of mica incorporated boards, slabs, tiles, or the like* — R. C. RAY (Science College, Patna)
- 32969: *Improvements in or relating to the manufacture of paints from mica* — R. C. RAY (Science College, Patna)
- 32970: *Improvements in or relating to compositions for electro-deposition of rubber* — J. C. GHOSH & G. VERGHESE (Indian Inst. Sci.)
- 32971: *Improvements in or relating to the extraction of rubber from Cryptotegia leaves* — S. S. BHATNAGAR, KARIMULLAH & U. SHANKER (Delhi Lab.)
- 33058: *Improvements in or relating to rubber lining of non-conducting surfaces* — J. C. GHOSH & G. VERGHESE (Indian Inst. Sci.)
- 33059: *Improvements in or relating to gas cleaning devices for use in conjunction with producer gas plants* — S. K. DAS GUPTA, M. L. KHANNA, K. A. NAIR & L. C. VERMAN (Delhi Lab.)
- 33077: *Improvements in or relating to the manufacture of plastic composition from pulverized mica* — R. C. RAY (Science College, Patna)
- 33078: *Improvements in or relating to the manufacture of para-aminophenol* — B. B. DEY, T. R. GOVINDACHARI & S. C. RAJAGOPALAN (Presidency College, Madras)
- 33114: *Improvements in or relating to the manufacture of paints from mica* — R. C. RAY (Science College, Patna)
- 33115: *Improvements in or relating to the rubber-lined metallic equipment* — J. C. GHOSH & G. VERGHESE (Indian Inst. Sci.)
- 33261: *Preparation of stabilized diazo salts and isodiazotates from mono-ordi-aminoanthraquinones* — R. J. MOUALIM & K. VENKATARAMAN (Bombay Univ.)
- 33473: *Improvements in or relating to the production of nitro derivatives of phenyl ethers* — B. B. DEY, T. R. GOVINDACHARI & H. V. UDUPA (Presidency College, Madras)

- 33649: *Isolation of new bitter principles from nim oil* — S. SIDDIQUI & C. MITRA (Delhi Lab.)
- 33650: *Separation of the bitter principles from nim oil and simultaneous purification of the oil* — S. SIDDIQUI & C. MITRA (Delhi Lab.)
- 33651: *Manufacture of new derivatives or subsidiary products from the physiologically active bitter principles of nim oil* — S. SIDDIQUI & C. MITRA (Delhi Lab.)
- 33786: *Improvements in the working life of jute or cotton mill bobbins, textile shuttles or the like accessories made of wood* — S. S. BHATNAGAR, L. C. VERMAN, S. M. KARIM & A. N. NAYER (Delhi Lab.)
- 33787: *A method of adjusting watches and time pieces* — L. C. VERMAN (Delhi Lab.)

1946

- 34040: *Improvements in or relating to containers of the cigarette case type* — G. SINGH & L. C. VERMAN (Delhi Lab.)
- 34210 (Sealed in U.K.): *Improvements in or relating to anthraquinone acid dyestuffs* — S. G. BEDEKAR & K. VENKATARAMAN (Bombay Univ.)
- 34211 (Sealed in U.K.): *A process for the preparation of 2:4 dichloro-1-amino-anthraquinone* — K. VENKATARAMAN & S. G. BEDEKAR (Bombay Univ.)
- 34410: *Manufacture of mosquito-repellant compositions* — S. SIDDIQUI, C. R. MITRA & A. V. SUBBARATNAM (Delhi Lab.)
- 34411: *An improved method for the conversion of nitro chlorobenzenes to the corresponding nitro anisoles and nitro phenetoles* — B. B. DEY, H. V. UDUPA & T. R. GOVINDACHARI (Presidency College, Madras)
- 34692: *Improvements in or relating to air separators for separating ground aggregate mass into different sizes* — G. D. JOGLEKAR (Delhi Lab.)
- 34754: *An improved process for the conversion of ortho- and para-nitro chlorobenzenes to the corresponding nitro anisoles and nitro phenetoles* — B. B. DEY, H. V. UDUPA & T. R. GOVINDACHARI (Presidency College, Madras)
- 34755: *An improved process for the preparation of 2-nitro, 4-chloro phenetole* — B. B. DEY, H. V. UDUPA & T. R. GOVINDACHARI (Presidency College, Madras)
- 34756: *An improved process for the production of ortho-dichloro benzidine (3:3-dichloro-4, 4-diamino diphenyl)* — B. B. DEY, T. R. GOVINDACHARI & S. G. RAJAGOPALAN (Presidency College, Madras)
- 34757: *Process for the production of 3, 6, 3', 6'-tetrachloro benzidine* — B. B. DEY, T. R. GOVINDACHARI & S. C. RAJAGOPALAN (Presidency College, Madras)
- 34766 (Filed in U.S.A.; sealed in U.K.): *Improvements in or relating to magnetic separators* — S. D. JOGLEKAR & L. C. VERMAN (Delhi Lab.)
- 34873: *An improved apparatus for the expulsion of shell liquid from bhilawan or cashew nuts* — S. SIDDIQUI & A. A. KHAN (Delhi Lab.)
- 34937: *Improvements in or relating to coating composition for cardboard containers* — S. M. KARIM & K. K. SARIN (Delhi Lab.)
- 34938: *Improvements in or relating to depolymerization of rubber* — S. SIDDIQUI, A. A. KHAN & B. C. MAZUMDAR (Delhi Lab.)

- 35328: *An improved method for the production of 2:4-diamino phenol* — B. B. DEY, H. V. UDUPA & T. R. GOVINDACHARI (Presidency College, Madras)
- 35331: *Manufacture of rubber sponges* — A. A. KHAN, B. C. MAJUMDAR & S. SIDDIQUI (Delhi Lab.)
- 35336: *Improvements in or relating to food containers made of paper, cardboard or fabric* — S. M. KARIM & K. K. SARIN (Delhi Lab.)
- 35337: *Improvements in or relating to the coating of cardboard containers for rendering them suitable for packing non-alkaline watery solutions, inks or the like* — K. K. SARIN & S. M. KARIM (Delhi Lab.)
- 35338: *Improvements in or relating to the manufacture of concentrated extracts of pyrethrum* — S. SIDDIQUI & A. V. SUBBARATNAM (Delhi Lab.)
- 35567: *Improvements in or relating to preventing the deterioration of pyrethrum preparations* — S. SIDDIQUI, A. V. SUBBARATNAM & V. SHARMA (Delhi Lab.)
- 35646: *An improved air cleaning and crank case ventilation system for internal combustion engines* — K. A. NAIR & L. C. VERMAN (Delhi Lab.)
- 36073: *Improvements in or relating to the production of cyclized rubber* — KARIMULLAH & U. SHANKAR (Delhi Lab.)
- 36074: *Improvements in or relating to the production of chlorinated rubber* — KARIMULLAH & U. SHANKAR (Delhi Lab.)
- 36162: *Improvements in or relating to the lathes particularly suited for glass working* — A. RAM, Y. P. VARSHNEY & B. V. J. RAO (CGCRI)
- 36163: *Improvements in or relating to the manufacture of double-walled or multi-walled glass flasks such as vacuum or thermos flasks* — A. RAM, Y. P. VARSHNEY & B. V. J. RAO (CGCRI)
- 36182: *Copper-silicon bronzes* — D. R. MALHOTRA, B. AGGARWAL & B. PRAKASH (B.B. & C.I. R., Ajmer)
- 36318: *Improvements in or relating to the manufacture of rubber compounds for lining or sealing containers or for making dipped goods or the like* — KARIMULLAH, U. SHANKAR & G. S. TEWARI (Delhi Lab.)

1947

- 37155: *Improvements in or relating to the preparation of aluminium alloys* — D. SARKAR, V. G. IYER & K. RAMAMURTHY (BHU)
- 37566: *An improved method for the production of 2, 4-diamino-phenol* — B. B. DEY, H. V. UDUPA & B. R. PAI (Presidency College, Madras)
- 38062 (Filed in U.S.A.; sealed in U.K.): *Improvements in or relating to the conversion of bituminous shell liquid to a non-vesicating drying product for the manufacture of air-drying varnish compositions* — S. SIDDIQUI (Delhi Lab.)
- 38063 (Sealed in U.S.A. & U.K.): *Improvements in or relating to compositions particularly suited for the manufacture of patent leather* — S. SIDDIQUI & D. C. DHAR (Delhi Lab.)

- 38064** (Filed in U.S.A.; sealed in U.K.): *Improvements in or relating to the conversion of bhilawan shell liquid to a non-vesicating drying product for the manufacture of lacquer varnish, stoving, enamels, water-proofing or like materials* — S. SIDDIQUI & D. C. DHAR (Delhi Lab.)
- 38823**: *Improvements in or relating to the production of distillery washes having alcohol concentration of 10 to 14 per cent by volume* — S. R. A. N. RAO & M. SREENIVASAYA (Indian Inst. Sci.)

1948

- 39320**: *Improvements in or relating to the activation of bauxite for bleaching vegetable oils and fats* — G. G. SUTAONE, S. A. SALETORE & P. S. MENE (Laxminarayan Institute of Technology, Nagpur)
- 39426**: *An improved method for the production of 2:4-diaminophenol* — B. B. DEY, R. K. MALLER, B. R. PAI & H. V. UDUPA (Presidency College, Madras)
- 39427**: *An improved method for the production of 2:4-diaminophenol* — B. B. DEY, R. K. MALLER & B. R. PAI (Presidency College, Madras)
- 39428**: *An improved method for the production of 4-amino-meta-cresol* — B. B. DEY, R. K. MALLER & B. R. PAI (Presidency College, Madras)
- 39429**: *An improved method for the production of 4-amino-ortho-cresol* — B. B. DEY, R. K. MALLER & B. R. PAI (Presidency College, Madras)
- 39441** (Filed in U.K. & U.S.A.): *An enzymic method for the production of calcium gluconate* — M. DAMODARAN, P. N. RANGACHARI & K. V. RAMAKRISHNAN (NCL)
- 39442**: *An improved method for the manufacture of sorbose from sorbitol* — M. DAMODARAN & S. S. SUBRAMANIAN (NCL)
- 39991** (Filed in Pakistan): *A process for the manufacture of a diastatically active moldy composition* — M. R. R. R. RAO & M. SREENIVASAYA (Indian Inst. Sci.)
- 40112** (Filed in Pakistan): *Process for production of distillery yeasts of high potency* — S. R. A. N. RAO & M. SREENIVASAYA (Indian Inst. Sci.)
- 40257** (Sealed in U.K.): *Improvements in or relating to manufacture of inks for stamping, printing, or like purposes* — S. SIDDIQUI, J. S. AGGARWAL & S. K. MATHUR (Delhi Lab.)
- 40261**: *A process for the production of 6, 6'-dichloro-3, 3'-diethoxy-benzidine (dichloro-ortho-diphenetidine)* — B. B. DEY, R. K. MALLER & B. R. PAI (Presidency College, Madras)
- 40370**: *A process for the recovery of useful by-products in the manufacture of enzymes with special reference to diastases* — M. R. R. R. RAO & M. SREENIVASAYA (Indian Inst. Sci.)
- 40735**: *An improved method for the manufacture of sorbose from sorbitol* — M. DAMODARAN & S. S. SUBRAMANIAN (NCL)
- 40752**: *Conversion of bhilawan shell liquid to a non-vesicating drying product for the manufacture of lacquer varnishes, stoving enamels or water resistant and flame resistant paints* — S. SIDDIQUI, K. K. SARIN & A. SINGH — (Delhi Lab.)

1949

- 40753: Preparation of new biguanide compounds — P. C. GUHA & S. S. GUHA (Indian Inst. Sci.)
- 40754: Preparation of chlorophenyl-dithiobiuret — P. C. GUHA & S. S. GUHA (Indian Inst. Sci.)
- 40968: The manufacture of a therapeutically active antibiotic substance containing pristimerin and dulcitol from *Pristimera indica* Willd. A. C. Smith, syn. *Hippocratea indica* Willd. (Celastraceae) — S. S. BHATNAGAR, P. V. DIVEKAR & N. L. DUTTA (St. Xavier's College, Bombay)
- 40969: Improvements in or relating to the manufacture of dulcitol — S. S. BHATNAGAR, P. V. DIVEKAR & N. L. DUTTA (St. Xavier's College, Bombay)
- 40970: Manufacture of active principle of therapeutic value designated by us as Pristimerin from *Pristimera indica* Willd. A. C. Smith, syn. *Hippocratea indica* Willd. (Celastraceae) — S. S. BHATNAGAR, P. V. DIVEKAR & N. L. DUTTA (St. Xavier's College, Bombay)
- 41336: Improvements in or relating to the manufacture of radio volume controls — G. R. TOSHNIWAL (Allahabad Univ.)
- 41338 (Sealed in U.S.A.): A plastic material from shellac and resinols like *bhilawan* shell liquid or cashew shell liquid — S. SIDDIQUI, K. K. SARIN & J. P. VARMA (Delhi Lab.)
- 41339 (Sealed in U.S.A.): Moulding powders from shellac and resinols like *bhilawan* shell liquid or cashew shell liquid — S. SIDDIQUI, K. K. SARIN & J. P. VARMA (Delhi Lab.)
- 41340 (Filed in U.S.A.): Improvements in or relating to the production of moulding powders from shellac and *bhilawan* resins — S. SIDDIQUI, K. K. SARIN & J. P. VARMA (Delhi Lab.)
- 41342: A process for the manufacture of foam glass — A. RAM, Y. P. VARSHNEY, B. V. J. RAO & K. D. SHARMA — (CGCRI)
- 41722-3: An arrangement for cleaning producer gas or the like — S. K. DAS GUPTA & M. L. KHANNA — (NPL)
- 41878: Manufacture of heat-insulating light-weight padding material for roofing boards or the like from agricultural waste — S. SIDDIQUI, K. K. SARIN, J. P. VARMA & P. DAYAL (Delhi Lab.)
- 42885: Preparation of modified oils from vegetable oils for use in paints and varnishes — J. S. AGGARWAL, N. C. BUDHIRAJA & P. G. SHARMA (NCL)
- 43149: Transformation of castor oil gel into a viscous liquid — J. S. AGGARWAL & A. S. GUPTA (NCL)
- 43164: Improvements in or relating to the manufacture of coating compositions — J. S. AGGARWAL & S. C. SETHI (NCL)
- 43292: Improvements in or relating to the manufacture of emulsifying compositions — K. K. CHAKRAVARTI & S. SIDDIQUI (Delhi Lab.)
- 43320: Manufacture of laminous compositions for use as expansion joints or the like — S. BAGHEE, B. C. MAZUMDAR & S. SIDDIQUI (Delhi Lab.)

1950

- 43321: *Improvements in or relating to the manufacture of bituminous jointing compositions* — S. BAGCHEE, B. C. MAZUMDAR & S. SIDDIQUI (Delhi Lab.)
- 43542: *Improvements in or relating to fermentation processes* — M. SREENIVASAYA & S. R. A. RAO — (Indian Inst. Sci.)
- 43543: *Process for improving the myrobalan liquor used in the myrobing process of East Indian Tannage of skins and kips* — K. S. CHOUDARY & R. SELVARANGAN (CLRI)
- 43544: *Preparation of modified glycerol phthalate alkyds* — S. L. KAPUR & K. K. SARIN (NCL)
- 43827: *Preparation of cation exchange resins* — H. A. SHAH & S. L. BAFNA (NCL)
- 43866: *Improvements in or relating to soil stabilization* — S. K. CHOPRA, K. R. M. RAO & N. K. PATWARDHAN (CBRI)
- 43979: *Improvements in and relating to the production of wrinkle finishes* — S. L. KAPUR & K. K. SARIN (NCL)
- 44144: *Improvements in or relating to the production of chlorinated rubber* — J. C. GHOSH, B. S. RAO, M. R. A. N. RAO, N. H. I. S. KRISHNAN & G. S. R. IYER (Indian Inst. Sci.)

1951

- 44359: *Preparation of ion exchange resins and the uses thereof* — H. A. SHAH & S. L. BAFNA (NCL)
- 44485: *Manufacture of picking band leather* — B. M. DAS, J. K. DE & S. N. BOSE (Bengal Tanning Institute)
- 44486: *Extraction of tannin from vegetable tannin substances* — B. M. DAS, B. MOOKERJEE & P. K. SARKAR (Bengal Tanning Institute)
- 44736 (Filed in U.K. & U.S.A.): *A process for the manufacture of alpha- and beta-kamlolenic acids and derivatives thereof from kamala seed oil* — J. S. AGGARWAL, V. N. SHARMA & S. C. GUPTA (NCL)
- 44737 (Filed in U.K. & U.S.A.): *Air drying wrinkle finish coating compositions* — J. S. AGGARWAL & P. G. SHARMA (NCL)
- 44746: *A new instrument for the measurement of infra-red radiation from the atmosphere* — R. S. KALE (Indian Meteorological Office, Poona)
- 44986: *Synthetic tanning materials* — S. SIDDIQUI & M. A. GHANI (Delhi Lab.)
- 45010 & 45150 (Sealed in France & U.K.; filed in U.S.A.): *A process for the recovery of beryllium oxide* — T. BANERJEE & P. B. CHAKRAVARTY (NML)
- 45025: *Improvements in or relating to electronic circuits with particular reference to the manufacture of a variance meter* — Y. D. ALTEKAR (India Meteorological Office, Poona)

Indian Inst. Sci.— Indian Institute of Science, Bangalore. CLRI—Central Leather Research Institute, Madras. NCL—National Chemical Laboratory, Poona. CBRI—Central Building Research Institute, Roorkee. NML—National Metallurgical Laboratory, Jamshedpur.

- 45088: *Synthetic tanning materials* — M. A. GHANI & A. L. S. RAO (CLRI)
- 45116: *Preparation of new bactericidal and surface-active quaternary ammonium compounds* — M. DAMODARAN & C. SIVARAMAN (NCL)
- 45117-18 (Filed in U.S.A.): *Improved process of extracting oil from oil-bearing material* — J. P. VARMA (NCL)
- 45138: *A new method for the hydrolysis of starch or dextrin to glucose* — R. P. PURI (FRI)
- 45547: *Preparation of photographic emulsion from comparatively inert gelatine* — K. P. SINHA (NCL)
- 45565: *Improvements in or relating to brass plating* — T. BANERJEE & S. K. RAY (NML)
- 45579: *Improvements in or relating to metallization of non-conductors* — T. BANERJEE & K. CHAKRABARTY (NML)
- 45583: *Manufacture of high quality gelatine from indigenous sources of hides and skins* — H. K. JOSHI, M. M. UPPAL & G. V. POTNIS (NCL)
- 45609: *Radio signals fading recorder* — S. S. BANERJEE & R. R. MEHROTRA (BHU)
- 45666 (Filed in Cuba & U.S.A.; sealed in Turkey): *Manufacture of nicotine sulphate from tobacco or tobacco wastes* — J. GEDEON & M. GOSWAMI (NCL)
- 45695: *Electroplating surface of non-conducting materials* — K. CHAKRAVARTY, B. N. GHOSH & S. K. ROY (Calcutta Univ.)
- 45696: *Improvements in or relating to metallization of surfaces of non-conducting materials* — K. CHAKRAVARTY, B. N. GHOSH & S. K. ROY (Calcutta Univ.)
- 45725: *An improved cooling apparatus* — M. L. GHAI (NPL)
- 45726: *Improvements in or relating to air-conditioning or cooling systems* — M. L. GHAI (NPL)
- 45840: *Improvements in or relating to accelerated heat bodying of drying oils* — S. A. SALETORÉ & P. SEN (Laxminarayan Inst. Tech., Nagpur)
- 45841: *Improvements in or relating to the isomerization of drying oils such as linseed oil* — S. A. SALETORÉ & P. SEN (Laxminarayan Inst. Tech., Nagpur)
- 46405: *A process for the preparation of tetraethyl pyrophosphate* — P. L. SAWHNEY & T. R. SESHADRI (Delhi Univ.)

1952

- 46575: *A process for saccharifying cellulosic material particularly agricultural residues* — N. R. KULLOOR & K. MANIVANNAN (Shri Ram Inst.)
- 46576: *A process for saccharifying cellulosic material such as agricultural residues* — N. R. KULLOOR & K. MANIVANNAN (Shri Ram Inst.)

CLRI — Central Leather Research Institute, Madras. NCL — National Chemical Laboratory, Poona. FRI — Fuel Research Institute, Jeelgora. NML — National Metallurgical Laboratory, Jamshedpur. BHU — Banaras Hindu University, Banaras. NPL — National Physical Laboratory, New Delhi. CFTRI — Central Food Technological Research Institute, Mysore.

- 46713*: *Utilization for the production of oleic acid, stearic acid, palmitic acid and/or stearin* — C. MITRA (NCL)
- 46714: *A solvent extractor* — Y. K. R. RAO (CFTRI)
- 46793: *Improvements in or relating to solvent extraction of oleaginous materials* — Y. K. R. RAO (CFTRI)
- 46794*: *Improvements in or relating to starch manufacture* — V. SUBRAHMANYAN, G. LAL, D. S. BHATIA, N. L. JAIN & G. S. BAINS (CFTRI)
- 46857*: *Cation exchange resins* — H. A. SHAH & S. L. BAFNA (NCL)
- 46945: *Manufacture of saponins (commercial grade) from Indian soap-nuts* — J. GEDEON (NCL)
- 46946: *Improvements in or relating to the manufacture of saponins. (commercial grade)* — J. GEDEON (NCL)
- 46947*: *Isolation and separation of bitter constituents from the trunk and/or root bark of nim* — S. BHATTACHERJI, & C. R. MITRA (NCL)
- 46981: *Solar Cooker* — M. L. GHAI (NPL)
- 46994: *Extraction of nicotine and an extraction tower for the purpose* — J. GEDEON (NCL)
- 46995: *Preparation of a malted milk product* — M. R. CHANDRASEKHARA, M. SWAMINATHAN & D. S. BHATIA (CFTRI)
- 47179: *Improvements in or relating to sugarcane wax* — A. B. KULKARNI (NCL)
- 47264: *A high speed recorder for use with infra-red spectrometers* — A. U. MOMIN (India Meteorological Office, Poona)
- 47347*: *A gas carburettor* — M. L. KHANNA & S. K. DAS GUPTA (NPL)
- 47348*: *A micro-photometer for rapid examination of spectrum plates or the like densitometric measurements* — A. U. MOMIN (India Meteorological Office, Poona)
- 47382: *A process for the modification of cashew nut shell liquid* — J. S. AGGARWAL & H. H. MATHUR (NCL)
- 47401*: *Chemical polishing of aluminium* — S. S. BHATNAGAR & B. R. NIJHAWAN (NML)
- 47439*: *A process for the manufacture of a mixed nitrogen-phosphorus fertilizer* — G. T. GADRE & J. GUPTA (NCL)
- 47446*: *Improvements in or relating to ion exchangers from coal, peat, lignite or the like* — R. P. PURI & P. K. BANERJEE (FRI)
- 47468*: *Resinous compositions suitable for cation exchange* — H. A. SHAH & S. L. BAFNA (NCL)
- 47580: *Preparation of a composite protein food* — V. SUBRAHMANYAN, M. SWAMINATHAN, N. V. L. RAO & S. KUPPUSWAMI (CFTRI)
- 47597†: *A process for the preparation of basic aluminium sulphate for use as a tanning salt or in dyeing or the like* — R. SELVARANGAN, M. A. GHANI & B. M. DAS (CLRI)
- 47766*: *Cation exchangers* — S. L. BAFNA & H. A. SHAH (NCL)
- 47802†: *Purification and refining of the seed oil of Karanja (Pongamia glabra Vent)* — C. R. MITRA (NCL)

*Accepted.

†Pending.

NCL — National Chemical Laboratory, Poona. CFTRI — Central Food Technological Research Institute, Mysore. NPL — National Physical Laboratory, New Delhi. NML — National Metallurgical Laboratory, Jamshedpur. CLRI — Central Leather Research Institute, Madras.

- 47815†: *Liquid preparations such as paints or the like coating compositions* — J. W. MCBAIN & J. B. PANDE (NCL)
- 47816†: *Duplicating inks or the like viscous liquid compositions* — J. W. MCBAIN & J. B. PANDE (NCL)
- 47817*: *A process for the manufacture of sodium tripolyphosphate* — G. T. GADRE, M. K. GHARPUREY & J. GUPTA (NCL)
- 47902*: *Improvements in the preparation of groundnut milk, curd and products* — V. SUBRAHMANYAN, M. N. MOORJANI & D. S. BHATIA (CFTRI)
- 47982†: *An improved process for the electrolytic production of high purity manganese dioxide* — T. BANERJEE & H. K. CHAKRABARTI (NML)
- 48275*: *Waterproofing of boards used for sound-proofing purposes* — N. V. C. RAO & J. B. PANDE (NCL)
- 48342†: *A method for the regeneration of the spent liquid from electrolytic manganese and electrolytic manganese dioxide baths* — T. BANERJEE & R. MANOCHA (NML)
- 48385†: *New method of preparation of active carbons from coals and lignites* — K. K. ROY, N. G. BASAK & A. LAHIRI (FRI)
- 48419†: *Enamels for wire wound resistors* — A. RAM, Y. P. VARSHNEY & S. S. VERMA (CGCRI)
- 48499† (Filed in U.K. & Germany): *A method for the utilization of manganese ore for the production of pure manganese sulphate and the regeneration of the sulphate spent liquid from electrolytic manganese and manganese dioxide baths* — T. BANERJEE & B. SEN (NML)
- 48529*: *A process for the thermal degradation of nim seed oil* — C. R. MITRA (NCL)
- 48530*: *Improvements in or relating to utilization of the nim seed oil* — C. R. MITRA (NCL)
- 48640†: *Preparation of starch from starch-bearing plant materials* — M. DAMODARAN & I. BABBAR (NCL)
- 48667†: *Improvements in or relating to the utilization of waste mica for the manufacture of insulating bricks, slabs, tiles or the like* — A. RAM & S. B. ROY (CGCRI)
- 48719*: *Preparation of fructose from agave plant* — M. SRINIVASAN & J. S. BHATIA (CFTRI)

1953

- 48873: *Preparation of o. o. diethyl phosphoric acid ester of 4-methyl umbelliferone* — P. L. SAWHNEY & T. R. SESHADRI (Delhi Univ.)
- 48923†: *Production of single-twisted or twin-twisted steel bars* — K. BILLIG (CBRI)
- 49022: *A latex combination particularly suited for can-sealing purposes* — J. BALLABH & D. RAGHUSATH (NCL)

*Accepted.

†Pending.

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- 49033: *Treatment of hides for production of gelatine or glue* — F. A. KINCL & G. V. POTNIS (NCL)
- 49054†: *A process for the treatment of bamboo to further its utilization in the manufacture of pulp, paper, board or the like* — G. M. VYAS, R. V. BHAT & K. A. CHOWDHURY (For. Res. Inst.)
- 49234†: *Preparation of titanium tetrachloride* — S. RAMAMURTHY (BHU)
- 49285†: *A process for the recovery of the constituent metals from copper base alloy scrap* — G. C. MITTER, S. G. DIGHE & S. D. GOKHALE (India Govt. Mint, Calcutta)
- 49353†: *Construction of floors* — K. BILLIG (CBRI)
- 49355†: *An improved process for the production of electrolytic manganese metal* — T. BANERJEE, H. K. CHAKRABARTY & N. DHANANJAYAN (NML)
- 49364†: *The manufacture of adhesive tapes* — N. V. C. RAO (NCL)
- 49425†: *Enamels for wire wound resistors* — Y. P. VARSHNEY & S. S. VERMA (CGCRI)
- 49441*: *Improvements in the manufacture of fruit pulps in the form of sheets, slabs or the like* — G. S. SIDDAPPA & B. S. BHATIA (CFTRI)
- 49510†: *Purifying and refining of non-edible, non-drying and so-called medicinal oils, such as Karanaja, Polang and Nageswar* — C. MITRA (NCL)
- 49524†: *Foam glass* — A. RAM & K. D. SHARMA (CGCRI)
- 49555†: *Boron free enamels* — A. RAM, N. R. SRINIVASAN & S. S. VERMA (CGCRI)
- 49590†: *Improvements in or relating to the manufacture of fruit juice powder* — G. S. SIDDAPPA & GIRDHARI LAL (CFTRI)
- 49635†: *A process for the recovery of elemental sulphur from copper pyrites* — G. C. MITTER, S. C. DIGHE & S. D. GOKHALE (India Govt. Mint, Calcutta)
- 49729†: *Improvements in or relating to the solvent extraction of coal* — A. LAHIRI & A. N. BASU (FRI)
- 49815†: *A process for the production of improved tan liquors from vegetable tanstuffs* — Y. NAYUDAMMA & R. SELAVARANGAN (CLRI)
- 49836†: *Manufacture of ether* — V. V. DESHPANDE & N. R. KULLOOR (Shri Ram Inst.)
- 49837†: *Production of pink enamels* — A. RAM, N. SRINIVASAN & S. S. VERMA (CGCRI)
- 49838*: *Improvements in or relating to the roasting of cashew kernels* — M. PRASAD, N. S. KAPUR & P. B. MATHUR (CFTRI)
- 49839†: *A process for the preparation of concentrated food products from groundnut kernels* — B. H. KRISHNA & B. C. SATYAN (CFTRI)
- 49851†: *Recovery of hydrochloric acid gas from unreacted chlorosulphonic acid in the manufacture of aromatic sulphonyl chlorides* — C. G. JOSHI, A. B. KULKARNI & R. C. SHAH (NCL)

*Accepted. †Pending.

NCL — National Chemical Laboratory, Poona. BHU — Banaras Hindu University, Banaras. CBRI — Central Building Research Institute, Roorkee. NML — National Metallurgical Laboratory, Jamshedpur. CGCRI — Central Glass & Ceramic Research Institute, Calcutta. CFTRI — Central Food Technological Research Institute, Mysore. FRI — Fuel Research Institute, Jealgora. CLRI — Central Leather Research Institute, Madras.

- 49852†: *Manufacture of azo-dyestuffs from cashew-shell liquid derivatives* — V. S. PANSARE & A. B. KULKARNI (NCL)
- 49880†: *Improvements in and relating to the manufacture of pre-stressed concrete* — K. BILLIG (CBRI)
- 50067†: *Synthetic tanning materials (syntans) for making leather* — D. MUKHERJI & B. M. DAS (CLRI)
- 50122†: *Process for the deodorization and recovery of volatile principles from substances such as food materials* — B. H. KRISHNA, S. K. S. LAKSHMI-NARAYANAN (CFTRI)
- 50173†: *A process for the utilization of low-grade coal in cement manufacture* — J. W. WHITAKER (FRI)
- 50339†: *Manufacture of physiologically active compounds from Cissampelos pareira, Linn. (Menispermaceae)* — S. BHATTACHERJI, V. N. SHARMA & M. L. DHAR (CDRI)
- 50340†: *Isolation of a new alkaloidal constituent from Cissampelos pareira Linn. (Menispermaceae)* — S. BHATTACHERJI, V. N. SHARMA & M. L. DHAR (CDRI)
- 50483†: *Soft iodo-bromide positive emulsions* — D. CHATTERJEE & J. S. GUJRAL (NCL)
- 50574†: *A magnetic fluid for crack detection* — K. C. SRIVASTAVA (NPL)
- 50758†: *A process for the preparation of modified alkyd resins* — J. S. AGGARWAL & P. G. SHARMA (NCL)
- 50782†: *Improvements in or relating to tanning liquors* — R. SELVARANGAN, M. A. GHANI & B. M. DAS (CLRI)
- 50803†: *Synthetic tanning materials* — N. VISHWANATHAN & B. M. DAS (CLRI)
- 50804†: *Synthetic tanning materials* — B. M. DAS & N. VISHWANATHAN (CLRI)
- 50805†: *A new fruit product* — N. L. JAIN, D. P. DAS & G. S. SIDDAPPA (CFTRI)
- 50806†: *An improved process for the enzymic unhairing of skins and hides* — S. BOSE, W. M. KRISHNA & B. M. DAS (CLRI)
- 50863†: *Synthetic tanning material* — B. M. DAS & D. MUKHERJEE (CLRI)
- †*Manufacture of upholstery leathers* — R. SELVARANGAN & B. M. DAS (CLRI)
- †*Process for the manufacture of tanned skins* — R. SELVARANGAN & B. M. DAS (CLRI)
- †*Manufacture of basic aluminium chloride* — R. SELVARANGAN & B. M. DAS (CLRI)
- †*Preparation of 2-hydroxy-3:6-dimethoxy acetophenone* — T. R. SESHADRI & S. K. MUKERJEE (University of Delhi)
- †*Manufacture of nicotinic acid* — G. D. SHAH & R. C. SHAH (NCL)

*Accepted.

†Pending.

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APPENDIX IV

RESEARCH UTILIZATION

Processes Transferred to Supply Development Committee, Royal Air Force, etc., for Development

High Tension Ignition Cable Testing Device for Field Use.
Slushing Varnishes for Metal Tanks for Petrol Storage, and for Rubber, Synthetic Rubber and Laminated Tanks for Carrying Petrol in Aircraft.
Patching Cement for Repairing Rubber and Synthetic Rubber Tanks.
Petrol-proof Hose-pipes.
Petrol Pump Diaphragms Proof against Petrol, Alcohol and Mixtures.
Petrol Tank Sealing Composition.
Smoke Candles and Distress Signals for Use in Land and Aerial Operations
Reclamation and Use of Perspex
Non-inflammable Water Resistant Cloth.
Substitute Hairlock.
Improved Hot Food Containers.
Furfurol.
Plastic Collapsible Tubes.
Lubricants from Vegetable Oils and Vegetable Oil-mineral Oil Blends.
Carbon Electrodes for Dry Cells, Arc Lamps and Arc Welding.
Tin Lining and Seaming Compound.
Water Detecting Composition.
Pyrethrum Cream.
Manufacture of Pyrethrum Emulsifier.
Thickened Fuel for Flame Throwers and Incendiary Bombs.
Anti-gas Cloth.
Treatment of Aviation Fuel for Reducing the Vapour Lock Tendency.
Cellulose Dopes
Clay Pigeons
Hydraulic Brake Fluid.

Processes Leased Out

Air Foam Solution — Fire Extinguisher Corporation, Calcutta.
Bhilawan Stoving Enamel and Allied Products — Jay Engineering Works Ltd., Calcutta.
Glass Substitutes — Indian Glass Substitutes Co., Simbhooli (Meerut).

Identity Discs — (1) Bharat Rubber Works, Barrackpore; (2) A. K. Sarkar & Co., Calcutta; (3) Namco Rubber Works, Coimbatore.

Jute Boards — (1) Karamchand Thapar & Bros. Ltd., Calcutta; (2) Juggi Lal Kamlapatt, Kanpur.

Laminated Paper Fibre Boards — Rohitas Industries Ltd., Dalmianagar.

Luminous Paints and Pigments — Muraka Paints & Varnish Works Ltd., Calcutta.

Oil Silks — B. N. Elias & Co., Calcutta.

Potassium Chlorate — Mettur Chemical & Industrial Corp., Mettur Dam.

Plastic Collapsible Tubes — (1) Premier Suppliers, New Delhi; (2) Radhakant & Co., Allahabad; (3) Heberlian Gareh & Co., Delhi; (4) Das & Co., Bombay; (5) Fazalbhooy Lab. Ltd., Bombay; (6) H. S. Mohamad, Bombay; (7) Industrial Products Ltd., Delhi; (8) B. R. Herman Mohatta Ltd., Karachi; (9) Bharat Carbon Ribbon Mfg. Co. Ltd., Lahore; (10) Mr. S. W. Sankaralinga Iyer, Madras.

Silver Paper and Glossy Transparent Paper — Karamchand Thapar & Bros. Ltd., Calcutta.

Small Carbon Electrodes — Estrella Batteries Ltd., Bombay.

Solid Fuel — Diamond Chemical & Pharm. Ind. Ltd., Lahore.

Stearic and Oleic Acids — Calcutta Chemical Co. Ltd., Calcutta.

Cork Substitutes — (1) Cork Products Co. Ltd. Baroda; (2) Delhi Cloth & Gen. Mills Ltd., Delhi.

Treatment of Manganese Ores for Dry Cell Manufacture — Estrella Batteries Ltd., Bombay.

Barium Chloride — Mettur Chemical & Industrial Corp., Mettur Dam.

Waterproof Paint for Indianite Roofing Slabs — Karamchand Thapar & Bros. Ltd., Calcutta.

Formaldehyde — Indian Institute of Science, Bangalore.

Petrol Pump Diaphragms — United Trading Co., Delhi.

Indigenous Moulding Powder SHP — S. N. N. S. Iyer, Madras.

Vacuum Pumps — (1) Scientific Apparatus & Chemical Works, Agra; (2) Shri Hanuman Sugar Mills Ltd., Calcutta.

Dye Extracts and Dyed Shades on Wool and Cotton from the Barks of Terminalia arjuna and Butea frondosa — Howrah Trading Co., Calcutta.

Dye Extracts and Dyed Shades on Wool from Tamarind Seed Testa — Howrah Trading Co., Calcutta.

Annatto Dye Extracts — Dairy Products & Equipment Mfg.

Atoxyl and Carbarsone — Zandu Pharm. Works Ltd., Calcutta.

Dettol type of Disinfectants — (1) The Bengal Chem. & Pharm. Works Ltd., Calcutta; (2) Swastic Oil Mills Ltd., Bombay.

Resin-impregnation of Jute Mill Bobbins — (1) Shri Hanuman Sugar Mills Ltd., Calcutta; (2) Turpentine Subsidiary Industries Ltd., Jwalanagar, Rampur State.

Extraction of Potash Salts from Molasses — (1) Ganesh Sugar Mills, Anandnagar; (2) Khaitan Sons & Co., Calcutta.

Calcium Gluconate — Gluconate Ltd., Calcutta.

Carbon and Graphite Electrodes — Aluminium Corporation of India Ltd., Jaykynagar (Burdwan).

- Butter Paper* — Dr. K. A. Hamied, Bombay.
- Tin Lining Compound* — Renderian Rubber & Chem. Works, Delhi.
- Fluids Used in Hydraulic Machines* — (1) Indo-Burma Petroleum Co. Ltd., Bombay; (2) Hansa Co. Ltd., Bombay.
- Nim Oil (Nimbidin)* — Birla Laboratories, Calcutta.
- Sintered Glass Filters* — The Industrial & Engineering Apparatus Co. Ltd., Bombay.
- Rubber Sponges* — (1) Khaitan & Sons, Calcutta; (2) K. B. Industries Ltd., Nagpur City; (3) Shri Dinesh Mills Ltd., Baroda.
- Dipped Latex Goods* — (1) Dhanjal Industries Jullundur; (2) Nanco Rubber Works, Coimbatore; (3) Mohd. Yunas Md. Ashfaq, Delhi.
- Ebonite Substitutes and Other Hard and Soft Rubber Goods from Rubber Waste* — Renderian Rubber & Chem. Works, Delhi.
- Solid Metal Polish* — Metal Polish Works, Qadian.
- Pyrethrum Emulsifier* — Imperial Technical Works, New Delhi.
- Resin and Plastics Dopes* — Hassan N. Mullick & Co., New Delhi.
- Steam-Proof plastics* — Olympic Rubber Works Ltd., Calcutta.
- Crown Cork Cement* — Simplex Mfg. Co. Ltd., Delhi.
- Rubberless Armoured Hose Pipe* — Free India Industries, Ambala.
- Loudspeakers and Radio Resistances* — Commonwealth Elect. & Industrial Corp., Delhi.
- Gelatine from Hides and Skins* — Indian Industrial Command, Jaipur.
- Newsprint from Bamboo* — Orient Paper Mills Co. Ltd., Calcutta.
- Solar Cooker* — (1) Devidayal Metal Industries Ltd., Bombay; (2) Jeewanlal (1929) Ltd., Calcutta.
- Groundnut Milk Curd* — (1) T. Stanes & Co. Ltd., Coimbatore; (2) Ram Chander Hajarimal, Sholapur.
- Pristimerin and Dulcitol* — Indev Ltd., Bombay.
- Carbon Slab and Rod Material for Brushes* — Beni Engineering Works Ltd., Calcutta.
- Thermocouple Ammeters* — Radio Lamp Works, Ltd., Poona.
- Adhesive Tapes (Sellotape Type)* — Norman Bros., Bombay.
- Blood Filter Pads* — Kumar Chemical Industries, Saharanpur.

Processes Released Free of Cost

- Manufacture of Anti-gas Cloth.
- Use of Vegetable Oil Blends as Lubricants.
- Manufacture of Bamboo Gramophone Needles.
- Manufacture of Coffee Husk Plastics.
- Fertilizers from Phosphatic Nodules.
- Manufacture of Urea.
- Manufacture of Mosquito-repellent Cream.
- Signal Smokes and Flares.
- Manufacture of Enterovioform.
- Purification of Indian Glass Sands.

Manufacture of Agar Agar.
Standardized Filter Papers for Gas Purity Tests.
Bamboo Strips for Weaving Combs.
Capping Cement for Electric Bulbs.
Improved Pencil Erasers.
Manufacture of Wet-ground Mica Powder.
Extraction of Orange Oil.
Manufacture of Pure Common Salt.
Aqueous Extraction of Oil from Castorseed.
Saponin from Soapnuts.

Non-Technical Notes

Laminated Paper Fibre Boards.
Manufacture of Dry Cells.
Resin Impregnation of Wood.
Manufacture of Glass Substitutes.
Bhilawan Stoving Enamels and Allied Products.
Manufacture of Luminous Pigments and Paints.
Air-foam Solution in Modern Fire Fighting.
Manufacture of Stearic and Oleic Acids.
Manufacture of Oil Plastics and Moulded Articles Prepared therefrom.
Substitute for Corks and Allied Products.
Manufacture of Dettol Type of Disinfectants in India.
Treatment of Manganese Ores for Dry Cell Manufacture.
Manufacture of Ionone.
Preparation of Atoxyl and Carbarstone.
Dye Extracts and Shades on Wool and Cotton from the Barks of *Terminalia arjuna* and *Butea frondosa*.
Dye Extracts and Dyed Shades on Wool from Tamarind Seed Testa.
Extracts of Annatto Dye for Colouring Vegetable Ghee, Milk, Ice-cream, Aerated Waters and Food Products in General.
Manufacture of Indigenous Moulding Powder-SHP.
Manufacture of Vacuum Pumps.
Resin Impregnation of Jute Mill Bobbins.
Plastic Collapsible Tubes.
Extraction of Potash Salts from Molasses.
Manufacture of Calcium Gluconate.
Manufacture of Ebonite Substitutes and Other Hard and Soft Rubber Goods from Rubber Waste.
Manufacture of Welding Flux for Aluminium and Its Alloys.
Manufacture of Glandular Products.
Drawn Laminated Mouldings.
Manufacture of Carbon Composition Resistances for Radio Purposes.

- Manufacture of Petrol-proof, Rubberless Carburettor Tubes and Armoured Hose-pipes.
- Manufacture of Mosquito-repellent Cream.
- Manufacture of Sintered Glass Filters.
- Utilization of *Nim* Oil and Its Bitter Constituents (Nimbidin Series) in the Pharmaceutical Industry.
- Bonding Composition for Plywood from Indigenous Raw Materials.
- Manufacture of Rubber Sponges.
- Manufacture of Phosphorus in India.
- Manufacture of Concentrated Extracts of Pyrethrum
- Manufacture of Loudspeakers.
- Manufacture of Compression and Injection Moulding Powders from Bhilawan Shell Liquid.
- Purification of Glass Sand.
- Characteristics of Photoflash Lamps.
- Rubber-lined Equipment for Chemical Industries.
- Water Detecting Composition.
- Manufacture of Gelatine from Hides and Skins.
- Production of Citric Acid.
- Manufacture of Calcium Gluconate.
- Manufacture of Filter Pads for Sterilizing Liquids.
- Manufacture of Moulding Powders and Hard Boards.
- Manufacture of Benzidine p-Aminophenol and 2:4-Diaminophenol.
- Manufacture of Orange Oil.
- Production of Vitamin C.
- Manufacture of 2:4-Dichloro-1-aminoanthraquinone and Acid Dyestuffs therefrom.
- Improvements Relating to Air Separators.
- Magnetic Separator.
- Ion-exchange Resins — Cation-exchange Resins.
- Emulsifying Composition for DDT.
- Air-drying Wrinkle Finish Compositions.
- Preparation of Drying Oils from Tobacco and Safflower Seed Oils.
- Plain and Wrinkle Finishes — Hard or Oil Modified Alkyds for Protective and Decorative Coatings.
- A New Vitamin and Mineral-fortified Composite Protein Food.
- Groundnut Milk Curds.
- Metallic Salts of Polymerized Fatty Acids.
- Saponins from Soapnuts and *Shikakai*.
- Nicotine Sulphate from Tobacco and Tobacco Wastes.
- Cation Exchangers from Indian Coals.
- Pristimerin — A New Antibacterial Agent.
- Dulcitol.
- Ceramic Colours and Glazes.
- Chemical Porcelain.

APPENDIX V

CSIR PUBLICATIONS

Books

The Wealth of India — A Dictionary of Indian Raw Materials and Industrial Products:

Raw Materials	Vol.	I (A-B)	1948
		II (C)	1950
		III (D-E)	1952
Industrial Products	Part	I (A-B)	1948
		II (C)	1950
		III (D-E)	1953

National Register of Scientific and Technical Personnel in India:

Vol. I Engineers	Part I	1949
	II	1950
	III	1951
II Medical Personnel	Part I	1950
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III Scientific and Technical Personnel	Part I	1952

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- Investigations on the Composition and Nutritive Value of Vanaspati, 1952.
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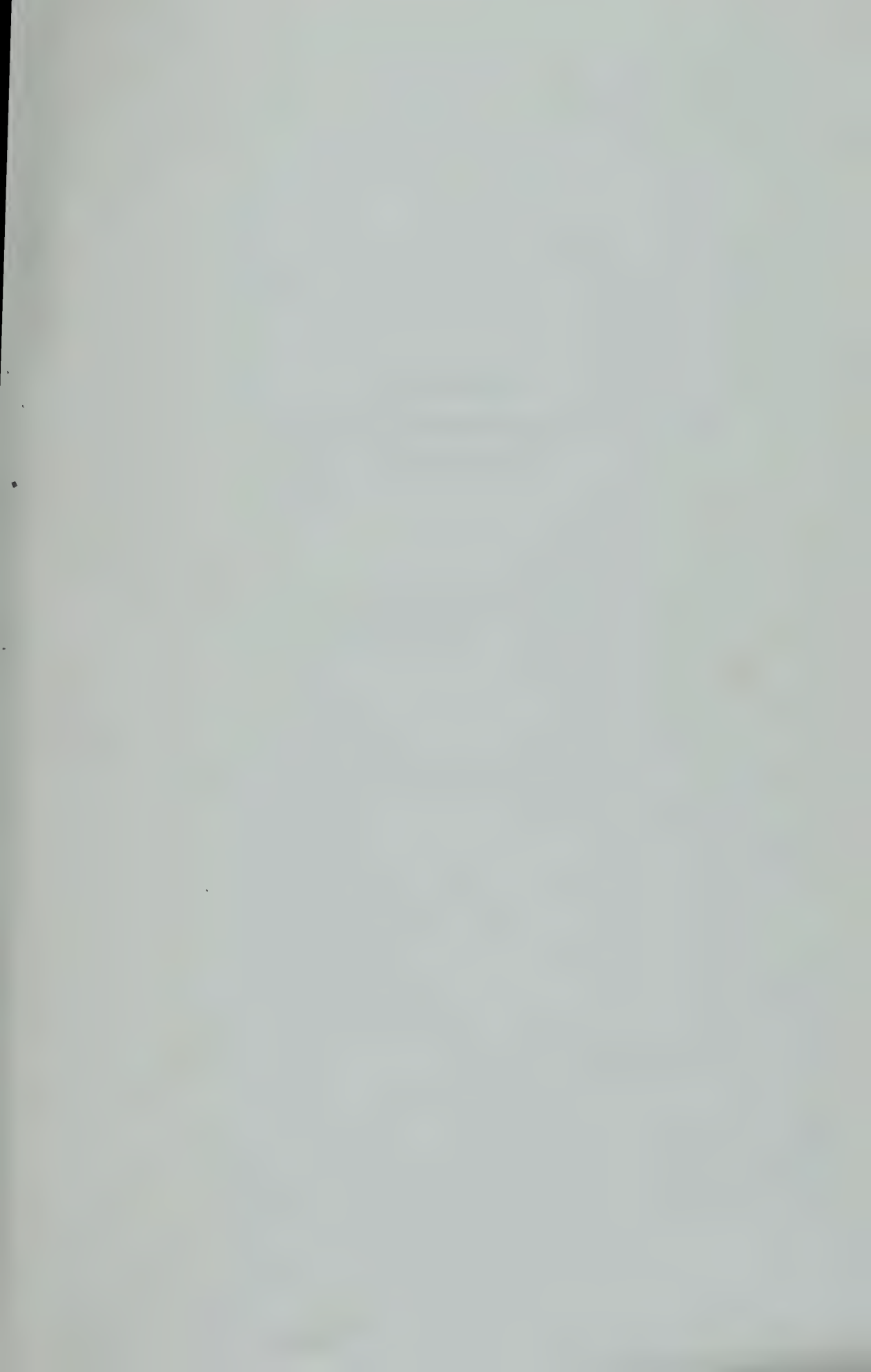
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